THIS PAGE Declassified IAW EO12958

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
1974		**00-00-1974 to 00-00-1974**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Air Force Contribution to U.S. Public Works	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Air Force Historical Reserch Agency (AFHRA),600 Chennault Circle,Maxwell AFB,AL,36112-6424**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**158**	

Study Number 143

Air Force Contribution to U.S. Public Works

Major John A. McAndrews, ed.

1974

The Early Years, 1897-1917

Establishment of a balloon park at Fort Logan, Kansas in 1897 began the history of U.S. air installations. A balloon built and flown there was used in the Spanish American War to observe the Spanish fleet in the harbor at Santiago and to direct artillery fire at the Battle of San Juan Hill in 1898. Brigadier General Adolphus W. Greely, Chief Signal Officer of the U.S. Army, had established the Signal Corps balloon section in 1892. Citing European aeronautical achievements and advances in his annual reports between 1892 and 1898, Greely urged appropriations that would enable the War Department to become active in aeronautics. His efforts were finally rewarded when the Deficiency Act of 1900 authorized $18,500 for a balloon house and administrative and instruction buildings at Fort Meyer, Virginia, near the nation's capital. This apparently was the first federal appropriation used for air installation construction.

Balloon activity by 1908 was centered at Fort Omaha Air Station, where the Signal Corps opened a balloon plant. Equipment from Fort Meyer was shipped there. Electrolytic cells and electrical machinery were ordered and installed. In May 1909 Signal Corps Dirigible No. 1 was sent to Fort Omaha for use in instructing the first Army pilots.

Fort Meyer was becoming the focus of heavier-than-air machines. The first Army airplane, built by the Wright brothers, was delivered on August 20, 1908 and made its first flight on September 3. Unfortunately, the first aviation casualty, Lieutenant Selfridge, occurred at Fort Meyer on September 17, 1908.

Airfield size and local weather conditions were among the earliest problems to confront the air pioneers. These factors have persisted as critical considerations in site selection and facilities construction to the present day. The Wrights' instruction of the first two Army pilots in 1909 had to be conducted on a field at College Park, Maryland, because the parade ground at Fort Meyer was considered too small to be safe. A small hangar was built at College Park in the autumn of 1909 as a temporary shelter. But, winter weather at College Park proved too severe for flying in open planes and without flying clothes. So the Army decided in December 1909 to move activities to Fort Sam Houston, Texas. The long move was made in February 1910. An inexpensive wooden hangar immediately was built on the drill ground to house the airplane, a starting tower and track were put in place, and training resumed.

Lieutenant G. E. M. Kelly* was killed during a primary pilot qualification flight at Fort Sam Houston in May 1911, and flying activities were discontinued. The Army had been committed to establish a flying school at College Park, and the repaired plane was shipped there. Earlier in the year, Lieutenant Roy C. Kirkland, a pilot applicant, had been assigned to College Park and put in charge of the construction of four new hangars.

---

*Kelly Field (later Kelly Air Force Base), Texas was named in his honor.

Weather conditions by November 1911 made it again necessary to move flying training south, this time to Augusta, Georgia. During the 1911-1912 winter operations, no permanent construction was undertaken. Flyers relied on tent hangars and hotel and farmhouse living quarters until they moved back to College Park in April. During the Army's absence from College Park, the U.S. Aeronautical Reserve and the Christmas Airplane Company were given permission to use the field and to erect an additional hangar. When summer flying again ceased in November 1912, there were eight hangars at College Park, which along with 12 airplanes and 51 men comprised "virtually the Government's entire aeronautical capital." Nevertheless, when the lease for the property expired in mid-1913, College Park was abandoned, marking the first of many base closures.

Air operations fell off at Fort Meyer and College Park, but the pace quickened at a new location near San Diego, California. In November 1912 the Army began paying the Curtiss Company $25 per month for the use of their hangars on North Island. Signal Corps quarters were a barn, a shed, and a canvas hangar. The officers lived in San Diego; enlisted troops were first quartered at Fort Rosecrans and later in tents on North Island itself. When the camp relocated from its original site in June 1913, the men moved to barracks in San Diego. Because the price demanded for installation of a power plant was prohibitive, there was no electrical power at the field. But in the fall, rent for North Island was discontinued and temporary

construction began, with the proviso that the Government could remove the buildings and vacate the premises at any time. Enlisted aviators, assisted by the Marines, did most of the construction work during 1913 and 1914. Enlisted men moved into quarters rented on North Island in December 1914 to relieve the problems of daily transportation to and from San Diego. An authorization of $2,000 was used to fund a temporary shack to house fifty men. The installation of two hangars, a 10-kw gasoline-electric generator, and some lathes in February 1915 further improved the site. The following months saw the completion of additional facilities, including portable field tent hangars built by a local firm. Because "flying boats" were used, seaplane hangars had to be built. A launching device was also fashioned which included a wooden railway into the water and a car-turntable combination. But this installation, later a major Signal Corps aviation school, continued as a temporary facility until 1917, when a campaign began to purchase the island for permanent military occupancy.

Balloon activities meanwhile had fallen off as the Army focused its attention on the airplane. In October 1913 all balloon schools were consolidated at Fort Leavenworth, and Fort Omaha was abandoned as an active post. For three years Fort Omaha was used by the Weather Bureau. Then, as the Germans began to use their Zeppelins for bombing, and as the U.S.' recognized the possibility of involvement in the European conflict, the Fort Omaha balloon school was reestablished.

The American Army also conducted air activities overseas in the early years. The first oversea installation was the Philippine Air School which opened in March 1912 at Fort William McKinley, near Manila, using one airplane and a two-plane hangar which the quartermaster built on the edge of the Army polo field. Heavy rains in the Philippines flooded the low ground at Fort McKinley causing the closing of the school from July 1912 to March 1913. To compensate, an interim base was established at the Manila Polo Club at Pasay, and a temporary hangar was built on the beach of Manila Bay. Pontoons were substituted for wheels on the two planes now available, and flying continued.

In October 1913 a Burgess coast defense seaplane was assigned to service at Fort Mills on Corregidor Island. A hangar was built on San Jose beach. A series of flights which followed represented some of the earliest attempts at reconnaissance and the direction of ground fire from military airplanes in a combat environment. In the winter 1913-1914 facilities at Fort Mills were improved. A cement floor was added to the hangar and a 225-foot marine railway was built into the water for launching the seaplane. From this seaplane early aviators took the first aerial photographs of Corregidor, and in 1914 demonstrated two-way radio telegraphy between air and ground. The following year Fort Mills was selected as the home base for the Second Aero Squadron. The commander, William Patterson, saw the need for rainproofing hangars and erecting rainwater tanks and reserve

fuel storage tanks. Plans for Fort Mills included a FY 1917 estimate of $145,600 for housing.

Efforts to establish a flying school at Fort Kamehameha, Hawaii, were less successful. It was set up in July 1913 using a tent camp. Two temporary airplane sheds were built in November, along with a machine shop. But tidal conditions proved hazardous to landings and takeoffs, and the winds were often treacherous. As a result, the school closed in June 1914. Fort Kamehameha was later considered as a possible site for the newly organized Sixth Aero Squadron, but the unit was assigned to the more favorable Ford Island in Pearl Harbor in September 1917.

General George P. Scriven, Chief Signal Officer, suggested in April 1913 that flying training at scattered civilian schools of the Wright, Curtiss, and Burgess companies as well as at the "temporary" Signal Corps schools in Augusta and Texas City be consolidated at a single air center. The Secretary of War in April 1914 approved a plan to locate the new air training center at San Antonio. Although funds were appropriated for new construction, no action was taken until March 1915.

Captain Benjamin Foulois, commander of the First Aero Squadron, was sent from San Diego to Fort Sam Houston to prepare plans and estimates for buildings and roads on the old target range, about four miles north of Fort Sam Houston. The sum of $48,200 included in the appropriation for FY 1915 funded the construction of living quarters for the commanding

officer, two six-set bachelor officers' quarters, one barracks building, one garage, a stable, and a machine shop. This construction provided quarters for only twelve of the twenty officers to be stationed there. Not enough money was available to build more housing, to install walks, roads, and sewers, or clear the area. Additional funds were sought, and the Signal Corp provided money to build two hangars, each capable of housing five planes. On the mounted drill ground there were two old hangars which Foulois obtained for temporary use until the squadron could move into its new post. Construction of the two new hangars was completed by January 1916. Foulois was authorized to tear down the old ones and move the material to the old target range for the use of his squadron. Using his own troops, he hauled supplies from Fort Sam Houston to the new area, built roads, walks, and drains, and prepared a landing field. At the urging of Captain Foulois, the Army Adjutant General decided at this time to regard this new aviation post as administratively separate from Fort Sam Houston. While assigned to this field in 1916, Foulois and his First Aero Squadron deployed to New Mexico and flew missions in support of General Pershing's punitive expedition against Pancho Villa. The Second Aero Squadron thus became the first and only tested tactical air unit prior to World War I.

Air base establishment continued actively in 1916. In the summer the Army inaugurated an additional flying school at the Signal Corps Aviation

Station, Mineola, N.Y. (later named Hazelhurst Field), on land leased from the Wright-Martin Aircraft Co. The men lived in tents, and worked in an office building and outmoded hangars remaining from earlier aviation days. Facilities were augmented in early 1917 with construction of a mess hall, barracks, storehouse, NCO quarters, and a hospital. Plans were drawn up for a lecture/instruction building and hangars to house 32 airplanes. Awareness of a potentially imminent conflict was seen in ancillary plans for four lighting towers to protect against sabotage.

Near Chicago, on land obtained from the Aero Club of Illinois, the Signal Corps began yet another flying school in November. Named Ashburn Field, it was used for several months before limited space and adverse weather caused operations to move in August 1917 to a site ninety miles away at Rantoul, Illinois.

Topography of a 700-acre tract in the lower Chesapeake Bay area near Fort Monroe was considered especially well suited for use as an aircraft experimental station. In the fall of 1916 the War Department paid $290,000 for the site. Initial construction costs were estimated at $1.5 million. The National Advisory Committee for Aeronautics* also located its research labs at the new Langley Field (now Langley Air Force Base).

---

*Later to become the National Aeronautics and Space Administration (NASA).

Yet another aviation school was opened in January 1917, using the field at a civilian flying school at Essington, Pennsylvania. Although the government purchased the land from the school in April for $31,056.55, the station was discontinued in November 1917.

Enlargement of facilities at the original school at San Diego had occurred meanwhile. Additional hangars, shops, barracks, and storehouses were built. But construction of a permanent school plant depended heavily on the services of a Quartermaster particularly qualified in construction work. As of April 1917 no one with those qualifications was available.

Limited and primitive resources at these locations and the men and planes operating on them were about to undergo drastic modification generated by the demands of America's first major war. Air fields would change from small, low cost, low income-producing sites to major public works developments.

The First World War, 1917-1918

French government officials requested in early 1917 that 4500 American pilots and their planes be on the European front by the spring of 1918. Response to this request generated the first massive expansion of air installations in U.S. history. The U.S. Army had less than 300 airplanes and only three major flying fields. The need for more training sites was obvious. The Army drew up plans for 24 new U.S. flying fields to train 1000 men each month. Rigid requirements were developed for landing areas and weather conditions favorable to winter flying. Topographical characteristics received primary consideration in site selection. Fields were to be flat, unobstructed, and with good drainage. A three-year lease with an option to buy at a fixed price was adopted as the contractual basis for site acquisition. This allowed the Government to either abandon the field without prejudice or to purchase it within three years at its unimproved value. Annual rents ranged from one dollar at Eberts Field, Lonoke, Arkansas to $20,000 at Wilbur Wright Field, Dayton, Ohio.

Organized within the Signal Corps in May 1917, the Construction Division began work on the new bases. Drawing on designs used at Canadian and other bases, Albert Kahn, a Detroit architect, and his staff developed a set of standard specifications in 10 days. Contractors were usually local people. Builders often started work merely on the strength of a letter indicating that a contract was being prepared. Some fields were practically completed before the contracts were actually signed. Fields

such as Wilbur Wright in Ohio and Chanute in Illinois were selected, rented, cleared and leveled, great hangars and other buildings were erected, and roads and railways built so rapidly that the installations were able to receive the first aviation training classes in July. Fifteen such fields were in use by December 1917. While these fields were under construction, Congress in July 1917, without a roll call vote, passed the Aviation Act appropriating $600 million for the total expansion program, including aircraft, supplies and personnel.

Colonel C. G. Edgar, engineer and contractor, was in charge of the building of the Air Service's training fields. Airfield construction costs ran from $800,000 upward for a four-squadron field, and were determined largely by the extent of leveling and drainage required.

During the first year, 47 main construction projects began in the United States and 35 were completed, at a cost of nearly $50,000,000 in obligated funds. Included were 15 single-unit and four double-unit flying fields, five supply depots, three troop "concentration camps" at ports of embarkation, three balloon schools, two repair depots, one experimental station, a radio laboratory and a quarantine camp. Most training facilities were concentrated in the southern states where year-round flying conditions prevailed. There were 27 major flying fields in the U.S. by the end of the war, augmented by a long list of schools and other support facilities.

During the period of World War I a total of 40,901 flying and nonflying personnel trained at these formal schools.

Fundamental concepts of air doctrine and tactics were needed in the early days of the war to determine the kinds of combat aircraft the United States would build. Since these concepts were still evolving and engineers were still developing design specifications, the War Department ordered its first combat airplanes from the more advanced French factories, and U.S. industry bent its initial effort upon the manufacture of training planes. The American aircraft industry was, in effect, created by the Government to meet World War I production needs. It involved equipping factories and procuring (and sometimes producing) the raw materials needed in airplane fabrication. Of the 10 airplane companies already in existence when the war started, four had built no more than 10 airplanes. Two other large industrial plants, the Fisher Body Company and the Dayton-Wright Company, converted to aircraft manufacture. Aircraft were tested at four fields built by the Construction Division at Dayton, Buffalo, Detroit and Elizabeth, N.J., near the plants where the planes were being produced.

When the Armistice ended the fighting, U.S. industry had produced less than 12 thousand airplanes, mostly training planes. Only 1216 had been accepted for combat by the American Expeditionary Forces in Europe. All of these were fighter and observation planes. Although bombers were

being built in the United States, none saw action in Europe.

Operationally separate from other air activities, the balloon program was also active during this period. Fort Omaha, which had been kept open since 1916, began instructions again in March 1917. In September it was greatly enlarged in size to accommodate the 61 officers and 2100 enlisted men in the balloon program. In December, Camp John Wise was opened near San Antonio as a winter training camp because of adverse weather encountered at Fort Omaha. Made a permanent installation in March 1918, Camp Wise had the capacity for 150 officers and 2200 enlisted men. Smaller balloon schools also opened at Lee Hall, Virginia (July 1917), Fort Sill, Oklahoma (September 1917), and Arcadia, California (June 1918).

Average life of a balloon operating in an active sector of the European front was 15 days. To keep up with the obvious need for balloons for U.S. troops and allied armies, rubber and textile industries joined forces and technologies. By war's end, they were producing an average of 10 balloons per day. Government-established gas plants and expanded private ones produced millions of cubic feet of hydrogen and helium.

Massive construction efforts in the United States were paralleled overseas. Original plans called for advanced flying training at Allied schools in Europe, since there were inadequate facilities, aircraft inventories and resources in the United States. When Allied forces imposed their own priorities on the use of existing European fields, the United States had

to assume the training burden by establishing her own large schools in Europe. Initial pilot training was still conducted in the United States. European schools were used mainly for familiarization and refresher courses. Eventually, 16 fields were activated in France, Great Britain and Italy, of which Issoudun in France was the largest.

Work got underway on the construction of the advanced flying school at Issoudun in July 1917. Much of the equipment and labor force was shipped from the United States. The first U.S. students arrived while construction was still going on, delaying their training. As was to occur at several similar sites, the flyers themselves assisted in construction work. The efforts of American engineers and workmen produced at Issoudun the largest air installation in the world, covering 36 square miles. By the end of hostilities Issoudun contained, on its 14 separate flying fields, 203 quarters buildings, 37 storehouses, 84 hangars and 15 miles of railroad.

Construction in support of U.S. air activity in Europe was not limited to schools. Building started on the First Air Depot at Columbey-les-Belles, France on November 1, 1917. By the end of the war it was the only large air depot in the Zone of Advance, and provided supply for 111 units--or practically all of the U.S. Air Service organizations at the front. It also became the central site for logistics demobilization activities and the dismantling of flying fields after the Armistice.

Equally as impressive was the construction of the Air Service Production Facility at Romorantin, France, begun in January 1918. The location was convenient in its proximity to both the front lines and the railroad linkages to the coast. Romorantin was a very extensive installation with 50 acres of floor space, eight miles of highway and 10 miles of road in the camp itself. Major aircraft assembly operations began there on May 11, 1918. Engines were also repaired and spare parts manufactured. The aircraft which had been assembled and repaired at Romorantin on November 1918 numbered in the thousands.

Another example of European sites was Air Service Acceptance Park No. 1. It was established at Orly, France in March 1918 to receive aircraft from foreign governments, test them, equip them, and prepare them for combat. Location near most French aviation factories facilitated operations. By the end of the war this base housed four fields, 76 hangars, scores of other buildings and miles of roadway. Construction costs approximated $1,220,000.

Initially, control of the rapid expansion in Europe fell to the Construction Division, a unit of the American Expeditionary Forces. However, Air Service projects after July 1918 became the primary responsibility of the Division of Construction and Forestry, Corps of Engineers. American manpower and resources were used extensively. Thirty seven construction companies were organized and sent to construction jobs on both the Continent

and in the British Isles. Construction units were supplemented by German prisoners and, later, Chinese laborers. Much of the material and equipment used was shipped from the United States. Included were such items as farm machinery, brought over for use in grading airdromes, and oxygen equipment and steel hangars fabricated in the United States. Initial shortages of materials, scarcity of personnel, and lack of storage facilities caused some delays prior to the summer of 1918. But by mid-1918 about $12,000,000 had already been expended on installations in France alone. Expansion in Europe was emanently successful. When U.S. combat air forces began to move to oversea locations, they were often greeted with facilities and housing arrangements constructed largely by American workmen and with American materials.

The surge of activity which began in 1917 with the French request for assistance was followed in 1918 by widespread public and Congressional dissatisfaction over the progress of the expansion program. Aircraft production in the United States was hardest hit with sudden terminations of defense orders. Because air installations had been built so quickly, construction programs were not severely affected by this cut-back. Many of the flying fields put together so hastily in the months of World War I survived to play a continuing vital role in national defense.

Between the Wars, 1919-1938

Signing of the Armistice in November 1918 ushered in an interbellum atmosphere of relative austerity for the air forces of the United States, lasting until the 1939 expansion program. By 1920 rapid demobilization had taken its toll: Congress had reduced funding; aircraft and engine orders had been cancelled; the World War I aircraft industry had been 90 percent liquidated; uniformed manpower had fallen far below authorized strength levels; and the Air Service had sold to civilian buyers large numbers of surplus planes and equipment. Although the war had pointed up the need for military aviation training schools, most of the existing schools were ordered to discontinue flying instruction when the war ended. Active fields in the U.S. were reduced to nine by January 1919. The chronic lack of funds, even during a period of some expansion in 1927-1930, was so severe that at no time prior to 1939 did the air forces have as many as 700 cadets entering flying schools in any one year.

Training activities stabilized by 1922. Cadets received primary training at Brooks Field and advanced training at Kelly Field, both near San Antonio. Scott Field, Illinois offered balloon training. Chanute Field, also in Illinois, housed technical schools, and an engineering school was conducted at McCook Field, Ohio. The Air Service Tactical School at Langley Field, Virginia taught leadership and aviation tactics.

War Department officials, following World War I, preferred moving units and functions to other existing locations rather than building new facilities

to accommodate changing requirements. For example, when the depot function was centered at Kelly Field in 1921, and a repair depot was moved in from Dallas, Kelly was unable to support the Air Service mechanics school there. The mechanics school moved to Chanute Field, Illinois and merged with the photographic school, moved from Langley Field, and the communications school, transferred from Fort Sill, to form the Air Service Technical School. Chanute Field had been established initially for pilot training in 1917. In 1919 it was all but abandoned, being used only as a storage depot, and the temporary war buildings had rapidly deteriorated. Consequently, locating the Technical School there in 1921 was considered a temporary expedient, and no money was spent on major refurbishment or new construction. A series of fires destroyed many of the buildings in about 1930. The Air Service in 1931 contemplated relocating the school at Dayton, Ohio. But public protests from the citizens of Rantoul, who wanted the school to remain for commercial purposes, resulted in a Congressional deadlock and withdrawal of funds. A site selection team appointed by the Secretary of War in 1934 recommended Denver as a new location for the school. After more Congressional compromise, part of the school was retained at Chanute where it remained until 1941.

Continuing reduction of appropriations during the post-World War I period also depleted the military airplane inventory to 754 operating aircraft by 1924. Many planes were obsolete, but there was no money with which

to buy new ones. This reduced the demand for permanent flying fields. As an alternative, the Air Service actively encouraged the development of civilian facilities which would meet the needs of military aviation. This, along with the development of special aerial maps by Air Service meteorologists, greatly enhanced infant commercial and civil aviation. By 1925 the Government Printing Office had published a bulletin listing data on 3460 landing fields across the United States. Although formal Federal assistance to civil aviation began to augment this private effort, many of the fields failed to meet military standards. Between 1933 and 1939 the government spent $137,931,950 in relief funds for the development of civil installations, but much of this went into building fields that were too small for the developing military aircraft.

Despite the postwar austerity of 1919-1926, the Air Service, operating with old airplanes and from worn-out fields, produced an impressive series of aviation "spectaculars," including flights across the continent and around its rim, a race against carrier pigeons, aerial photography and radio communications improvements, border and fire patrols, air mail operations, and a long succession of new records for speed, altitude, distance and endurance.

Congress passed the Air Corps Act on July 2, 1926. In addition to changing the name of the Air Service to the Air Corps, the statute provided for significantly enlarging the force:

> The Secretary of War is hereby authorized to equip and maintain the Air Corps with not to exceed one thousand eight hundred serviceable airplanes, and such number of airships and free and captive balloons as he may determine to be necessary for training purposes, together with spare parts, equipment, supplies, hangars, and installations necessary for the operation and maintenance thereof.

This statute authorized a five-year expansion program. Lack of immediate funding, however, reset the expansion plan to the period July 1927-June 1932. Increases were to occur in more or less equal yearly increments. Congress, however, never provided adequate funds to enable growth at the rates and quantities originally intended. Expansions occurred mainly during the first three years; by 1930 the effects of the great depression were felt in the military construction program as elsewhere. But given the problems of implementing the 1926 Air Corps Act, facilities construction and station improvement seemed to fare comparatively better than corresponding manpower and airplane build-ups.

Most activity centered in the South and Southwest as it had in the early years of aviation. The School of Aviation Medicine moved in June 1926 from Mitchel Field, N.Y., to Brooks Field, Texas. The school initially occupied a large balloon hangar at Brooks. Early the following year plans were drawn up for a new two-storied building for offices, a lecture room,

a library, examining rooms and a laboratory. The medical school moved into this, its first permanent building, in July 1927. Along with the primary and advanced flying schools, it fell under the control of the Air Corps Training Center recently established at nearby Duncan Field.

Brooks and Kelly Fields, the centers for flying training, lacked adequate classrooms and student housing. Construction was of World War I vintage, with a five-year estimated life span. In addition, San Antonio had grown in size by 1926. The changing proximity to the city presented growing safety problems for the air activity from these bases. In June 1927, General Frank Lahm suggested building a single, large field several miles distant from San Antonio. Here he planned to house all flying training. Four million dollars was appropriated shortly thereafter for construction of what was referred to as the "West Point of the Air." Construction began in November. The field was laid out using a British design which placed the hangars on a knoll in the center of the area and aprons and runways on three sides (or four in the case of the British plan). The site was named Randolph Field in June, 1930 while still only partially completed. The headquarters, Air Corps Training Center was moved from Duncan Field to Randolph in October 1931 and primary and basic training activities were transferred in from nearby Brooks Field and from March Field in California. All primary and basic flying training in the Air Corps was conducted at the great flying center at Randolph until July 1939.

Advanced training was given at neighboring Kelly Field. The School of Aviation Medicine also moved from Brooks to Randolph Field in 1931 and occupied a new building with bigger and better accommodations.

During the five year expansion following the creation of the Air Corps, a great number of new units formed up at Langley Field in Virginia. This taxed facilities there for the Air Corps Tactical School, which consequently relocated in late 1928 at Maxwell Field, near Montgomery, Alabama. This, in turn, forced the expansion of Maxwell, which was about the same size as it had been during the war. In the spring of 1929 Congress appropriated $789,000, of which $100,000 was for Tactical School facilities and the rest for other construction. Problems in preparing Maxwell Field delayed until mid-1931 the school's actual move. Difficulties in acquisition of 750 acres of land also delayed until 1932 the building of living quarters for students. But by 1934 the construction was completed on 87 sets of officer quarters, a complex of noncommissioned officer quarters, garages, a quartermaster warehouse, a water tank and other structures. Maxwell Field rapidly grew into a large, well-developed air installation.

Army and Navy aviation shared a grant of $15 million from the Public Works Administration (PWA) in October 1933. This grant, far below the amount originally requested, was to be used both to purchase aircraft and to construct facilities. The construction funding given to the Army was well suited to the main purpose of the federal grant, that is, providing

employment to the jobless. Because PWA funds were distributed through the White House's overall allocations of funds to emergency relief programs, the resulting construction efforts often bypassed traditional Congressional control of military real estate and construction.

Unfortunately, severe criticism fell upon the ensuing procurement program. Accusations of irregularities and profiteering were leveled at its managers. The Military Establishment was accused of taking unfair advantage of emergency public works and relief programs to fund unnecessary projects. A sweeping Congressional investigation in 1934 looked at the War Department's relations with business and industry, and included the alleged

> ". . . leasing of public property by the War Department to private concerns under terms and conditions alleged to be contrary to the public interest; . . . profiteering in the purchase of War Department property; (and)... awarding of contracts without competitive bidding."

Although these issues involved monies distributed in the Public Works Administration grant, the controversy concerned mainly the Air Corps' procurement of aircraft rather than base construction and improvement. Neither the Air Corps, the Budget Bureau, the Congress nor the White House escaped the blame leveled by various investigators and critics. The prevailing estimate by 1935 was that the Air Corps expansion program had failed, especially when

results were contrasted to 1926 expectations.

Japan's increasing belligerence, illustrated by her denunciation of the Washington and London naval treaties, fostered fears in Congress and the War Department that America's defenses, far from expanding, were fast becoming inadequate. Florida Congressman James M. Wilcox introduced a bill in 1935 to fund construction of new air bases in coastal areas and outlying U.S. possessions. The proposed legislation was hotly debated. It was championed on the military side by Generals Douglas MacArthur, Benjamin Foulois and others, and by retired Generals Charles E. Kilbourne and "Billy" Mitchell. In order to retain some flexibility in site selection, these officers successfully recommended modification of the original draft which had called for bases in specifically identified locations. Passed by the 74th Congress and signed as Public Law 263 by the President on August 12, 1935, the bill was known as the Wilcox Act. It authorized the Secretary of War to effect "the selection, construction, and installation of frontier defense bases for the Army Air Corps" in each of 10 broad geographical areas of the United States. What was later named McChord Field near Tacoma, Washington, was one of a limited number of construction actions following the passage of the Wilcox Act. Facilities exchanges with the Navy forced diversion of much of the available funding to building "substitute" rather than new bases. But the influence of the Wilcox Act was felt strongly in following years. The 1939 expansion program was

generally free from logrolling and political pressures largely because the Wilcox Act was already on the books. The act was also considered sufficient legislative authority for much of the rapid build-up through the early years of World War II.

The Second World War, 1938-1945

Prewar expansion of the Air Corps continued at a slow pace. In 1936 Congress approved and authorized an increase from 1800 to 2300 aircraft. By the crucial autumn of 1938 long production lead times had kept the aircraft inventory at only 1600. The interbellum concept of a totally defensive air force was entrenched strongly in national policy and had, by this time, crippled the Air Corps. Augmented by a persistent theory that the Navy was responsible for the air above the high seas, defense planners played down any extensive long-range strike capability or oversea operation by the Air Corps. And continental air defense was generally ill-defined and obscure.

Shaken out of lethargy in late 1938 by the crisis over Czechoslovakia, many national leaders recognized the increasing power of Hitler's Luftwaffe in the complex calculus of international politics. President Roosevelt and his advisers were alert to the possibility that America's air arm might again be called to the test. An extraordinary flurry of upward revisions in numbers of needed new aircraft gave evidence of a sharp attitude change in the White House regarding the development of an effective air force. Roosevelt, at a November 1938 conference, expressed a strong belief that the Air Corps was the weakest of all U.S. forces. He saw an urgent need for a rapid build-up to 20,000 planes. Political realities forced him to revise the request to 10,000. The fact that he did not accompany this with a request for a similar increase in bases and men led to speculation that

many of these planes were destined for the Allies. But due in large measure to forceful arguments by General 'Hap' Arnold and others that a well-balanced combat force required bases as well as planes, installation expansion was included in follow-on planning. FDR, in April 1939, designated $300 million for air expansion, 40 per cent of which was for air base and other non-plane items. The Secretary of War allotted $62,800,000 for air base construction. The Army sought supplemental funds for Air Corps construction from the WPA and received in July an additional $3,961,000.

The build-up during the next several years represented the most intense and concentrated expansion in air history. The modest initial system of 17 Army air bases and four depots in the United States in 1939 grew to 114 major Army Air Force aviation facilities by the time Japan attacked. When expansion peaked in 1944, there were 461 major bases, a part of a complex of over 2200 air installations throughout the nation. In addition, the Air Corps and the WPA worked closely together to develop and improve civil airports for military use, thereby significantly augmenting the expansion program.

Governing military expansion in 1939 was a philosophy of continental defense. The existing base structure, however, had not been fashioned with this concept in mind. Geographic locations, physical characteristics, and structural make-up were often ill suited to the emerging demands of hemispheric defense and the weapon systems being developed. Only since

the Wilcox Act in 1936 had planners given consideration to confounding attacking enemy aircraft by judicious placement of bases. At the suggestion of the new Chief of Staff, General G. C. Marshall, strategic planners also began to make the location of new bases compatible with the operating range of U.S. aircraft in order to maximize air defense resources.

Initially, both Congress and the War Department exercised close and detailed control over site selection. By 1940, preliminary site selection was the joint responsibility of the Air Corps, as the using agency, and the Corps of Engineers or the Construction Division, under the Quartermaster General, as the constructing agency. As the press of rapid rearmament continued, more and more authority devolved into the hands of lower echelon commanders in the various defense sectors.

Domestic site selection now was based on many new factors. In addition to considerations of weather conditions and strategic location, the topography, soil composition, natural drainage characteristics, accessibility, and obstructions were evaluated. Adequate approach space and the expanse of the airfield itself were most important. A contemporary observer in 1940 wrote that ". . . the field must be sufficiently extensive in all directions to permit the take-off of entire squadrons or groups of military aircraft at the same time. In the tactical operations of our Air Forces, the military authorities cannot wait for one airplane to get off the ground and fly out of the way before the next airplane takes off. They take off in groups."

General Arnold, early in the 1939 expansion, directed that funds be used to build temporary, mobilization-type structures except for technical buildings which were to be permanent. He estimated that permanent construction for all new bases would cost about $128 million, twice the allotted funds, and that permanent construction would be too time-consuming. This mobilization policy was followed into the subsequent build-ups in 1940-1941.

One of the first concerns in mid-1938 was the training of flyers in the large numbers required. Existing civilian schools were used extensively for primary flight instruction. Nine such schools opened in July 1939; more early in 1940. Civilian mechanics schools were also used. In many of these cases the contractor furnished the necessary facilities. Some constructed barracks to house students; some used hotels, YMCA's and private homes.

Civilian schools handled primary flight training, but the Air Corps still was unable to provide all follow-on basic and advanced instruction at Randolph, Kelly and Brooks Fields as heretofore. Antiquated construction--much of it pre-World War I and intended to be only temporary--was put to heavy use at these bases. Of necessity, new training bases sprang up, especially in the South and Southwest where weather was most favorable for flying. By December 1941 there were 28 new fields in operation or under construction which would provide training. Often these new facilities,

such as Westover Field, Massachusetts and MacDill Field, Florida, required extensive condemnation and evacuation proceedings and clearance of tax claims. The faster and heavier aircraft being brought into use also imposed requirements not previously confronted. For example, B-17 bombers required taxiways and runways of a strength and length which had not been provided in the original design of older fields like Hamilton in California. Commercial engineers recommended a minimum runway length of 7,000 feet. At Maxwell Field, Alabama, buildings were adequate and of good quality, having cost 64 per cent of total construction expenditures there as of June 1940. But the high costs of prospective runway extensions and facility improvements led the Office of the Chief of the Air Corps to estimate at one point that it would be cheaper to build an entirely new installation.

Bombing and gunnery ranges, essential to combat training, were too few and too small. Air Corps headquarters recognized this deficiency as early as 1937, considering it the limiting factor in combat preparation. One of the best ranges existing in 1939 was the 1460-acre tract near Valparaiso, Florida. It was donated the year before, and was called Eglin Field. It made use of both the overwater ranges in the Gulf of Mexico and range areas in the Choctawhatchee National Forest. But a checkerboard of civil holdings severely limited operations there.

Location and development of additional ranges during the 1939-1940 expansion program partially alleviated the problem. Fund shortages and prolonged negotiations, however, delayed acquisition of some of them.

Radio ranges were also needed to serve rapidly increasing communication and navigation requirements. New ranges were installed at Maxwell Field, Alabama; Post Field, Fort Sill, Oklahoma; Scott Field, Illinois; in Panama and on the Hawaiian island of Oahu. By the end of 1940, the Army Airways Communications System comprised 36 operating stations.

Plants which made up the aircraft industry, although not properly considered military installations, also experienced phenomenal growth as they responded to the sudden increase in orders for military planes. To expedite production the government often found it necessary to build facilities at its own expense and to lease them to the manufacturers. Among factors considered in site selection for these plants were the proximity to transportation and power sources, availability of raw materials, and vulnerability to enemy attack. The dominant factor, however, was the availability of manpower. The post-depression years of 1939-1940 had produced pockets of both high and low employment. Much effort was dedicated to locating new facilities to bring work to the idle. As with military installations, the original construction, continuing operations, and post-war utilization of these industrial plants greatly affected the economies of the areas where they were located.

Build-up of hemispheric air defenses was not confined to the continental United States. Military appropriations for FY 1940 provided for new bases in the Alaska-Hawaii-Panama Canal defense triangle. Strategists increasingly viewed Alaska as a logical Japanese invasion route to the Western Hemisphere. Work began in late 1939 on Elmendorf Field near Anchorage, one of the first experiences in air base construction in the Arctic.

There was no Atlantic counterpart to the Pacific defense triangle. But an urgent requirement for such a system was apparent by mid-1939. The British Isles, French West Africa, the Canaries, the Azores and the Cape Verde Islands constituted the first line of defense of the Western Hemisphere. Defense planners desired to reinforce these with a defensive screen of other installations. An emergency strip at Borinquen Field, Puerto Rico was transformed with great haste and efficiency into a major air field. Bases existed in the Caribbean area which would satisfy much of the immediate need. The problem was to secure the rights to them. Negotiations which followed culminated in the celebrated "Destroyer Deal" in which President Roosevelt and Prime Minister Churchill agreed to exchange 50 American destroyers for 99-year lease rights to bases in Britain's American possessions. Included were stations in the Bahamas, Jamaica, Trinidad, St. Lucia, British Guiana and Antigua. Rights to fields in Newfoundland and Bermuda were included gratis. The announcement of this

transaction in August 1940 served as a clear signal to the world that America was aligning itself against Nazi aggression occurring on the European continent. By the end of 1940, defense agreements had been concluded with every country of South America except Argentina, further securing the hemisphere from invasion.

Heretofore responsible for Air Corps construction, the Quartermaster Corps was overtaxed by the demands of so rapid a build-up. On November 19, 1940 General Marshall directed all Air Corps construction transferred to the Army's Corps of Engineers. This historic transfer took place without appreciable delay in scheduled projects.

Burgeoning Axis naval presence and the growing threat of enemy air attack capability from bases such as those in South America spurred an expansion of the U.S. Army Air Corp to 84 combat groups in March 1941. The new build-up, more than tripling the original 25-group structure, required a fairly extensive redistribution of existing facilities and the construction of yet more new bases. The increasingly long list of flying schools, technical schools, tactical bases, reception centers, depots and ranges was still geared to a hemispheric defense posture. The receipt of funds from War Department, WPA, and Civil Aeronautics Administration (CAA) appropriations, as well as lump sum construction monies allocated by the President, and the wide use of quickly erected temporary structures enabled

expansion to proceed without notable incident.

Expansion was interrupted by the attack on Pearl Harbor in December 1941. A succession of further build-ups quickly followed, from 84 to 115, to 224, to 273 combat groups. This acceleration, and the need for base building programs to precede actual force increases, demanded unprecedented support from the nation's construction resources. The multitude of problems faced by installation planners was set against a backdrop of a suddenly modified defense philosophy, which included the idea of offensive air power for direct use in World War II.

Plans called for maintaining one third of the air units in the United States, with one major installation and four sub-bases to support each combat group. Training of the great numbers of flyers needed was geared to 70,000 new pilots per year. From emergency legislation in the early weeks of 1942 the recently established U.S. Army Air Forces (U.S.A.A.F.) received $779,371,725 for its construction program, and the CAA was given $59,115,300 for additional airport development. Beginning with the site selection stage a decentralization of construction procedures came into effect. Base-building was under the active direction of the U.S.A.A.F. Construction directives were expedited and initial surveys and acquisitions began early in 1942 for a new set of bases.

Sites which had received favorable recommendation in surveys conducted prior to Pearl Harbor were re-evaluated by Headquarters, A.A.F., using a

scoring system which awarded 30 points for strategic and tactical application and 20 points each for weather; terrain; suitable location in regard to ground forces, ranges and civil airports; costs; and availability of civilian housing. Training bases sprang up throughout the South and Southwest. Construction was of an inexpensive, theater-of-operations design, following the guidelines set by the War Department. Problems involving leasing and contracting, costs of materials, labor shortages, and occupancy rights were dealt with as they arose. Maximum use was made of existing state and municipal airports and other facilities. The "fighter base every five miles" concept which prevailed throughout 1942 produced countless building projects ranging from large jobs at major installations to small refurbishment projects at local municipal landing strips. Exclusive military leases on CAA-constructed airports allowed construction to proceed there also. Air congestion in the South and Southwest soon forced training into Arkansas, Tennessee and Illinois where drainage, grading, and weather conditions often plagued construction sites. The renewed search for sites was made more difficult by a growing land scarcity. One officer was heard to protest that the West Coast Training Center would have to expand "into Northern California, Oregon, or Washington where the rain raineth and all fields so far surveyed will have to have a mat."

Rapid and vast expansion made it all but impossible for Congress to exert any effective control over land purchases. A wartime pattern emerged in which lump sums for purchase of military posts were available with no stipulations regarding land rights and maximum costs. This arrangement, although necessary, created dissatisfaction in Congress over land purchases.

Flight schools soon proliferated. An observer wrote:

> "To the multitudes of Americans who passed through them in the grim days after Pearl Harbor, the names of early training fields and schools like Luke, Mather, Keesler, Chanute, and Lowry conjure up a variety of memories. Some were dustbowls and some were swamps. Some men slept in ivy-covered brick barracks, others in tarpaper huts and winterized tents. Everywhere was breathless haste. As General Arnold reported, 'It was not unusual to find a training field with dozens of planes flying above it, bulldozers on the ground finishing the earthwork, cement mixers turning out concrete for runways yet to be built, and men in the open still clearing the brush off what had been grazing land.'"

New technical training installations also rushed into operation. Initially, construction was unable to keep up with demand, especially in the housing of students. Much use was made of hangars, tents, and leased hotels and schools. By September 1945 the eight stations originally built for Technical Training Command, with combined housing capacity for 131,000, had cost $120,673,862--among the AAF's most expensive stations.

Four air depots existed in 1939 and were barely adequate for the small Air Corps of pre-war days. There were 11 in operation or under construction when Pearl Harbor signaled a drastic increase in requirements, especially in storage and maintenance facilities. During 1942, storage space expanded from 4 million to 7.7 million square feet, and, by August 1944, to 24 million square feet of covered warehousing. The cost of depot improvements between January 1942 and June 1944 ran to $120 million.

Persistent fear that U.S. littorals were vulnerable to sudden Pearl Harbor-like air attacks persuaded commanders to incorporate passive defense measures into base expansion. Site selection was made more difficult by the necessity to avoid coastal areas. Dispersal and concealment of installations received the highest attention. Generals Arnold and Eaker wrote that ". . . an air base is an area and not a locality. It comprises a central airdrome with many outlying or dispersion airdromes, so that airplanes can be scattered when attack is imminent." A.A.F. directed dispersed layouts for all new bases built within 300 miles of the Gulf of Mexico. Much money was spent on taxiways and revetments. A complete dummy airdrome was constructed near Richmond Army Air Base, Virginia, for training purposes. On the West Coast the A.A.F., in close coordination with the U.S. Commissioner of Public Roads and the state highway departments, constructed flight strips to be used primarily for dispersal of tactical aircraft. The flight strips

were located parallel to major highways in areas from 25 to 75 miles from established bases. The strips measured 500 by 5000-8000 feet. A total of 21 such strips were constructed using $15 million appropriated to the Commission of Public Roads in late 1941.

Initial flurries of such emergency measures slowed in early 1942, although some dispersed and camouflaged facilities continued somewhat longer. By October 1942 it was apparent that war would not be fought on the United States mainland. General Arnold's order to discontinue such activity closed the book on passive defense measures initiated in the weeks following Pearl Harbor.

Germany extended her war zone in the spring of 1941 to include Greenland and Iceland, and routinely posted ships and aircraft in their vicinity. President Roosevelt became convinced of the necessity to reinforce Greenland's inadequate defenses against possible attack. The initial policy of maintaining air and sea patrols soon gave way to plans for establishing air bases on Greenland. The value of such facilities, along with bases in Iceland, as points on a Great Circle ferry route to Europe enhanced the attractiveness of the undertaking. An agreement was signed with the Danish minister, financing was programmed, and a site selection survey was authorized. The dispatch of a small Marine brigade to Iceland at the request of both Great Britain and the Icelandic government marked the beginning of activity there.

Development of Narsarssuak Field in Greenland exemplifies air base construction under extremely difficult conditions. The field was laid out on a site 50 miles up Tunugdliarfic fjord at the junction of the Narsarssuak River, on an enormous gravel bed, or moraine, formed by a defunct glacier. Dwarfed by surrounding mountains rising to heights above 5000 feet, its relatively level glacial outwash inspired its name, Narsarssuak, which in the Greenland dialect means "great flat place."

The first task force arrived on the location, previously selected sight unseen, on July 6, 1941. The ensuing construction was hampered by inadequate equipment, personnel tensions, obdurate terrain and uncertain weather. Fog and overcasts were common. Foehn winds, often exceeding 100 miles per hour, caused frequent interruption of work and necessitated extensive precautions against damage to men and equipment. Skeletal defenses engendered a fear of German raids. Fire hazards were great because of the timber construction, year-round interior heating, and inadequate water supply. Men, critical materials and equipment were lost at sea enroute to Narsarssuak. Nevertheless, in January 1942, the runway received its first aircraft.

Defenses were bolstered in Iceland also. The Icelandic government made a portion of Reykjavik airport available to the U.S. Army, but it was inadequate for extensive military operations. The Pentagon issued directions for the construction of an additional airfield in the Reykjavik area capable

of accommodating B-24 heavy bombers. The survey team had to consider some unique factors, such as the availability of fill, water table elevations, and supply sources. Keflavik was selected, and work began in October 1941. Logistics, climate, and geography combined to offer almost every conceivable obstacle to construction. The terrain was a tundra-like swamp broken with boulders and rock outcrops, vaguely mapped, devoid of roads and subject to violent winds. Working during the extremely short days of winter, despite gales, snow, and sleet the troops successfully completed by April 1, 1943, sufficient asphalt pavement and other essential facilities for defense, operation, and maintenance, to make the main field usable. Ingenious engineering improvisations and utter disregard of physical hardship were frequently necessary to overcome normally insurmountable climatic obstacles to successful asphalt paving, dock construction, girder erection, and major earth moving. In spite of all difficulties this project was completed four months ahead of the most optimistic schedule, with an expenditure of only 60 per cent of the funds allotted.

War operations approached their height in early 1943. General Arnold now began curtailing or reducing domestic construction projects. By June of that year there were sufficient base facilities in the United States to support military air requirements. Housing capacity reached its maximum of 2.4 million persons. The peak count of separate installations, in December 1943, numbered 345 main bases, 116 sub-bases, and 322 auxiliary fields.

A.A.F. now promulgated a strict policy of full utilization of existing facilities to replace the massive and unlimited construction effort that had marked prior years.

Extensive closure actions were foreseen by December 1943 as the war approached a victorious conclusion. Preliminary planning and policy formulation began at that time. Excess leaseholds were the first of the surplus properties to be disposed; many contracts had already been cancelled. Excess fields were first put on a "standby" status, pending the clarification of redeployment policies at the end of the war. Congress in 1944 began to reassert control of Air Force real property acquisitions which had devolved to lower command levels during the emergency build-up. Expressing dissatisfaction at some of the purchases and disposals, Congress advocated the reestablishment of Secretarial review of questionable cases and proclaimed that the value of a base as a permanent military installation should be the guiding principle in deciding its fate.

Following V-J Day surplus facilities were speedily relinquished. By the end of 1945 A.A.F. domestic installations were reduced to a total of only 429, of which 174 were either inactive or on standby status.

Construction had not stopped completely, however. New weapons systems were being introduced into the air force inventory, and existing facilities were not always fully able to accommodate them. Almost all construction during 1943-1944 related to the needs of very heavy bombardment

aircraft and the training of their crews. The B-36 bomber, for example, which was then under construction would impose requirements much in excess of anything previously known. The landing surface would have to absorb a 30,000 lb gross load, much greater than the upper limits of existing runways built using highway construction technology. Consequently, during 1943-1944, some bases underwent improvements at the very time that nearby bases were being disposed of.

Essentially new facilities were also being established to respond to technological advances. The Secretary of War, in February 1945, approved plans to establish White Sands Proving Ground in New Mexico as a rocket-firing installation. That same year a WAC Corporal rocket attained a height of 43.5 miles. Shortly thereafter, the Army launched from White Sands the first V-2 rocket fired in the United States. White Sands thus presaged the construction requirements of the impending missile age.

Base building activity also directly supported prosecution of the war in combat areas overseas during 1944-1945. Examples are legion. In Europe, tactical air forces accompanied General Patton and the Allied armies' drive across France. The exceptional efforts of the aviation engineers and supply sections in such units as General Hoyt Vandenberg's Ninth Air Force made possible the immediate repair and improvement of forward airfields. This allowed flyers to operate from strips located near the advancing front lines.

Construction units were also active in the Pacific. A set of five bomber and six fighter fields were built in China between January and May 1944. Called the Chengtu Project, it was under the direction of General Claire Chenault. The sheer magnitude of the effort, in which 400,000 Chinese workers labored with primitive tools and ancient methods of construction, has been compared to the building of the Great Wall of China, but under a typically American time schedule.

Construction of Pacific airfields during the invasion of the Philippines in October 1944 was a deciding factor in the hotly contested air battles over Leyte. And the troops landing on Leyte's beaches were protected by fighters operating from a runway hastily completed by engineers at Tacloban.

To support the final assault on Japan, construction units on Okinawa and Ie Shima accomplished what has been called "the largest aviation engineering project ever attempted." General MacArthur and Admiral Nimitz directed that 22 airstrips be constructed within a matter of weeks. The project involved 25 miles of paved airstrips, augmented by hardstands, taxiways and service aprons equal to 400 miles of paved two-lane highway. It required the movement of five and a half million truckloads of coral and earth. Although interrupted by heavy rains lasting several days, and hampered by the delayed arrival of almost 50,000 construction troops, the aviation engineers rapidly completed strip after strip in time to receive incoming battle-ready air combat units.

Other combat area installations, often built under difficult conditions, played critical roles in the war effort. Among them are Clark Field in the Philippines, where engineers experienced many problems in late 1941 while preparing for arrival of the B-17s and the staff organization of the newly created Far East Air Force. Henderson Field on Guadalcanal was indispensable to victory in the Solomon Islands. More than 12 Allied forward airfields in North Africa figured heavily in the Tunisia/Libya campaign in 1943. The long list of similar bases is testament of the prodigious effort by oversea aviation engineers working simultaneously with construction workers in the United States.

Cost of base construction during World War II is difficult to determine. Excluding the cost of land, the estimated capital value of installations used by the Air Corps in the continental United States as of June 1940 was $104 million. By September 1945 the figure had risen to three billion dollars. During the period of the war emergency 29.5 per cent of the total War Department expenditures for facilities went to the construction of A.A.F. command installations. By any measure, the effort of the nation's construction resources from 1938 to 1945 was monumental; facilities growth over pre-war levels was logarithmic. Not since then have military air bases experienced so rapid and drastic a change.

Chart I
STATUS OF AAF CONTINENTAL FACILITIES
1941 - 1945

	7 Dec 1941	31 Dec 1941	31 Dec 1942	31 Dec 1943	31 Dec 1944	VE Day	VJ Day
Main and Sub-bases	114	151	416	461	414	412	401
Auxiliary Fields	x	x	198	322	309	291	269
Contract Pilot Schools	x	x	69	66	14	14	6
Rented Office Space (3)	x	x	x	x	79	109	103
Hotels (4)	x	x	464	216	75	75	75
Bombing and Gunnery Ranges	x	x	x	x	480	473	433
Civilian and Factory Schools	x	x	66	47	21	17	16
College Training Detachments	x	x	16	234	2	1	1
Specialized Depots (5)	x	x	12	41	68	51	43
Miscellaneous Installations	67 (1)	46 (2)	29	32	44	30	30
Total Installations (6)	181	197	1270	1419	1506	1473	1377
Training Establishments	112	151	479	833	464	454	434
Grand Total (6)	293	348	1749	2252	1970	1927	1811

Notes: (1) Forty-seven of these miscellaneous installations were airfields projected or under construction. (2) Thirty-three of these miscellaneous installations were airfields projected or under construction. (3) AAF sites and other small leased installations are not included. (4) This item includes hotels which were leased, owned, or on a contractual basis. (5) Totals include sub-specialized depots. (6) Items marked "x" are representative of missing information and consequently make the totals unrepresentative for comparison.

The Post-War Period, 1945-1950

Post-war draw-down of forces and bases offered the opportunity to reconfigure the system of installations, to better serve a changing military environment. General Eisenhower observed that the existing distribution of military bases related mainly to the needs of Indian fighting. The rapid facilities reduction program aimed at disposing of relatively useless or poorly located sites and concentrating strength in a smaller number of modified and improved bases. Many existing temporary wartime structures were fast deteriorating to the point where maintenance expenses were prohibitive. The demands of a changing air defense mission also influenced decisions about base dispositions. Strategic and continental air defenses demanded larger, more complex bases dispersed throughout the world. The many training bases, on the other hand, exceeded requirements.

Congress once again began to assert policy guidance. Although it urged rapid demobilization, Congress was sensitive to the pitfalls encountered during pre-World War I reductions. Required levels of military preparedness would be maintained this time. Scarce "excess" commodities were to be made available to the general public. And the national economy was to be disrupted as little as possible by demobilization. Congress delegated broad authority to administrative agencies to get rid of unwanted holdings through "executive disposal." Insofar as new acquisitions were concerned, however, Congress tightened its control, rescinding surplus war appropriations, setting

dollar limits to the building of new, permanent facilities, and restricting transfer of funds into military public works coffers.

The U.S. Air Force became a separate and independent branch of service in 1947. With it came the responsibility to manage the expansion and modification of its own air bases and ultimately to state requirements for future facilities in annually prepared budget requests. Coordination of construction projects was a complicated and time consuming process in peacetime, involving the Air Force, Department of Defense, Bureau of the Budget, and Congress. A Director of Air Force Installations estimated that bureaucratic processing would necessitate at least a three-year planning lead time. Fund shortages often exacerbated the situation. In most cases the Army's Corps of Engineers continued to effect actual real estate purchases and construction contracting for Air Force projects.

Air planners saw clearly the need to begin building defenses against a growing Soviet air capability. The USAF in late 1947 proposed an aircraft control and warning network of 411 radar stations, 374 of which were to be located in the United States. Costs were estimated at $400 million. Congressional approval was not accompanied by necessary funding, however. When the Communists siezed Czechoslovakia in February 1948, the continental United States had but one active radar station; four more were operating in Alaska but only for part of the day. A war scare generated by the crisis in Europe caused an increase in planned air defenses, especially for the

northeast and northwest sectors of the United States and Alaska. Several old wartime radar sites were reoccupied. The Joint Chiefs of Staff assigned primary responsibility for continental air defense to the Air Force. Since funds were not yet appropriated for the proposed 411-radar complex, the Air Force submitted a modified plan to build a permanent system of 75 early warning radar stations and 10 control centers in the United States and Alaska. Congress put funds toward its estimated cost of $86 million in 1949, but several years of development and construction time were anticipated before the system could be fully operative. Supplemental funds enabled some expansion of the planned network. Government owned land would be used for the radar sites.

Russia's first explosion of an atomic device in August 1949 convinced the government to step up the pace of air defense by accelerating the radar build-up. The Air Force expedited completion of a net of 44 stations in California and instituted dispersal of defense aircraft to alternate bases. Work was underway on strategic outposts at Elmendorf, Ladd, and Eielson Air Force Bases in Alaska, and at bases in Newfoundland, Iceland, and Okinawa by 1950, for eventual occupation by the Strategic Air Command's long range bomber units.

Housing for men and their families posed one of the Air Force's most critical problems after 1945. Because some bases were located far from urban centers, the expected post-war military housing shortages could not

relie on civilian residential communities for short-term relief. Although the Air Force did what it could with the limited funds available, the situation continued to worsen, lowering morale and affecting the retention of airmen. In 1948 the Secretary of the Air Force stated that family quarters were available to only a fourth of those legally entitled to them. Half of these structures were makeshift conversions of antiquated barracks and other buildings.

Congress, in August 1949, authorized a $500 million fund to underwrite Federal Housing Authority mortgage insurance for privately financed housing on or near military installations. Known as the Wherry-Spence Act, it provided some relief.

The Air Force also planned to construct 26,595 units at 49 stateside bases. Even if the complete program had been finished, it would have provided less than half the required houses. But by mid-June 1950 work had begun on only 4292 units. The need for cold-weather housing in Alaska and typhoon-proof housing on Okinawa made both these areas difficult problems. Firms in Japan and the Philippines handled most of the construction projects on Okinawa. Because of the high cost of utilities and construction, private builders did not display much interest in the 3,000 to 4,000 units planned for Alaska.

More than half of the 207,000 bachelor airmen still lived in temporary wartime barracks at the beginning of 1950, and the remainder lived in obsolete permanent-type barracks. The old Army squad room, uncomfortable and unhealthy, was home for tens of thousands of airmen. The Air Force drew up new dormitory designs calling for two to four men in a room and costing from $2,000 to $2,300 per man to build. In 1950 Congress authorized the Air Force to build enough of these to house only 5,250 airmen in the United States and 700 overseas.

More than half of the USAF bases in 1950 were temporaries and had been deteriorating for five years. This created a big recurrent maintenance job, further complicated by the chronic shortage of money. In 1950 the Air Force estimated that a five-year program of major repairs would cost $90 million.

Emergency repairs and base modifications depleted most of the funds appropriated for repair and maintenance during 1945-50. Money often had to be diverted from one base to pay for badly needed repairs at another. Typhoons did $6.5 million worth of damage on Okinawa and Guam in 1949. Tornadoes and fires during the first six months of 1950 cost $800,000 in repairs to base facilities in the United States. Because of the temporary construction at many bases, Air Force fire losses were serious, running to about $150,000 a month in the United States and even more overseas. They were particularly heavy in arctic regions like Alaska.

Before the airbase, radar and housing problems of the postwar period could be resolved, the invasion of South Korea launched the Air Force into yet another expansion.

The Korean Conflict, 1950-1953

Changing world conditions demanded yet further expansion of air facilities during the period 1950-1953. The Korean Conflict provided the catalyst for a speed-up in acquisition of rights to bases worldwide. The need for airfields in direct support of combat on the Korean penninsula drew much attention. Simultaneously, the global deterrence mission of the Strategic Air Command (SAC), the heightened air defense measures for the U.S. homeland, and the progress of the Tactical Air Command (TAC) toward a global strike force created additional requirements. President Truman's policy was to modernize existing bases and utilize surplus resources if at all possible; if not, build new bases. As a result, few new facilities were built in the U.S., but oversea areas saw extensive installation construction.

No single factor so seriously handicapped Air Force operations in the war in Korea as the persistent lack of adequate air facilities. Obstacles to base construction were many, but the principal problem was a shortage of properly qualified aviation engineers.

Korea had maintained only five of the 11 airfields built during the Japanese occupation. Of these, only two --Kimpo and Suwon--were suitable for high performance aircraft. The others had runways which were too short, or merely sod strips. Consequently, initial air support came from units flying out of Japan; even these could mount only a limited jet operation.

To move air groups near to the battle zones, plans were made in July 1950 to use aviation engineers and civilian contractors to lengthen and improve six of the old airfields. These plans went awry as three fields quickly were lost to the North Koreans and others proved too primitive to be modified immediately. Airfields at Pohang and Taegu underwent a quick-fix of the sod-and-gravel runways, followed by construction of a parallel 5000 foot runway using pierced steel planking (PSP). Engineers found that they had to excavate the soggy clay to a depth of five to ten feet and fill the excavation with crushed stone. With the help of hundreds of Korean laborers the fields were completed in short order, but still remained unsuitable for more advanced aircraft.

A major military move into Korea was planned in August, and required at least six airfields in readiness. Generally unfavorable terrain, combined with ever present personnel shortages, generated the policy of rehabilitating other old airstrips, some as they were being taken back from the enemy. These sites were characterized by high water tables, hazardous obstructions, limited areas for runway extension, and surface weakness. Because these runways had been cratered by bombs and lacerated by tanks, PSP was used extensively.

Taegu Air Base, in southern Korea, was typical. It was renovated in September 1950 to provide a 5700-foot runway for combat aircraft. Laid over recently recovered rice paddies, the PSP soon developed irreparable

subsurface defects. Dust kicked up by the jet blasts caused engine damage. Jagged edges of the planking caused frequent tire failure. Finally, in May 1951, despite continued remedial work, and pounded by up to 10,000 landings and takeoffs per month, the PSP went to pieces. A long term project then began to construct a 9000-foot cement concrete runway.

General Earle E. Partridge saw the urgency for all-weather airfields in Korea and in March 1951 requested their development. The shortage of construction personnel, however, limited projects to on-the-spot, company-sized improvements and preparation of short runways to accommodate combat operations. When the Communist forces launched their spring offensive in April, the lack of functional air bases in Korea caused the Eighth Army to rely heavily on long-range air support.

Engineer units, manned and equipped by the Department of the Army and augmented by USAF air installation specialists, continued to be plagued with shortages in personnel, equipment and spare parts. In May 1951 temporary construction stopped and more permanent facilities were begun. Taegu, Suwon and Kunsan Air Bases led the build-up. The simultaneous arrival of several units of engineers marked the initiation of an ambitious construction program to build 9000-foot runways, jet fuel storage tanks and cross country pipelines, and permanent living quarters made mainly of prefabricated steel Quonset huts. Korean workers and

contractors provided the labor force for much of this construction. Besides the modernized prewar airstrips, there arose an entirely new jet fighter airfield on a flood plain in west central South Korea near the village of Osan-ni. It boasted a 9000-foot runway of cement-concrete, and was ready to receive its first "Sabre" fighter-bombers in December 1952. By that time a system of airfields existed in Korea which would serve as the operating bases for the USAF for the remainder of hostilities.

Monumental effort produced this system and sustained it until war's end. The 9000-foot semipermanent runways, for example, which in World War II had each required 1.5 battalion months of work, in Korea required 4.5 battalion months. But the added effort paid off in markedly reduced operating costs and greater combat effectiveness of aerial fighting units.

Existing World War II airfields in other oversea areas quite evidently did not meet the need for alternate strategic bases which the Air Force had come to consider vital to its operations. Construction began on new bases in Germany, Greenland, Morocco, and Spain. In France, Germany, Libya, Japan and elsewhere other fields were improved and expanded. The history of these is one of human and technological successes over innumerable obstacles of geography, topography, weather, international tensions, military logistics and high costs. From the ordeal came not only a responsive and modern global airbase system but the development of innovative and pioneering concepts in airfield design and construction.

Inadequate bases in the continental U.S. prompted a domestic rebuilding program during the years of the Korean Conflict. The decision to expand from 48 wings to 95, then to 143 exacerbated an already critical problem, especially in the area of flying training facilities. Flight line modifications, required by the advent of new aircraft, centered mainly around acquiring more space, extending runways, building longer overruns, and widening aircraft approach corridors. The USAF sought to locate new bases at least 15 miles from the nearest major community to avoid conducting flying operations too close to crowded urban areas. Engineers responded to problems that had developed in safety, maintenance and firefighting by developing new construction materials with improved fire-protective qualities. Many existing safety hazards were eliminated structurally, and safer building materials were used.

The dollars appropriated for the military construction program in the Air Force during fiscal years 1951 and 1952 totalled $1.4 billion and $2.1 billion respectively. They were spent for emergency modifications of World War II bases, for AC&W sites, for a long-range air proving ground, for extensive construction of housing and office buildings, and for bases overseas.

The construction program suffered a temporary setback in 1953 after the change in administration. In an effort to cut government expenses, President Eisenhower directed that all expenditures be reviewed and pared

as much as possible. The Director of the Bureau of the Budget and the Secretary of Defense announced in early February 1953 that work should continue only on those projects which were clearly essential. On these, the "strictest standards of economy" would be employed. No construction contracts would be awarded after February 7, 1953, until each project had been reviewed and specifically cleared. Secretary of Defense Wilson also directed that advertisements for bids should cease on March 1, except on those construction contracts reapproved by the Secretaries of the Air Force and Defense.

Review of projects placed an enormous administrative burden on Air Force agencies and delayed about $700 million of new construction work for at least two months. About 180 items considered no longer essential were reduced or eliminated from programs. Action on more than $1.9 billion of Air Force construction was suspended for varying periods of time. In May 1953, when the Department of Defense temporarily cut the USAF strength from 143 wings to 120, another readjustment became necessary. This changed plans for the use of 17 bases in the continental United States and 17 overseas. Construction was deferred on 14 bases in the United States and six overseas. The Air Force cancelled projects already under contract and, in some cases, where construction had begun.

Despite the end of hostilities in Korea, the Air Force experienced a continuing series of challenges relating to their installations in the years following 1953.

The Post-Korean Era, 1954-1957

During the post-Korean period the spectre of atomic warfare returned to vogue the World War II policy of dispersing aircraft to as many fields as possible. Construction, begun in many areas during the Korean Conflict, continued to fruition. Airfields became operational in places such as Thule, Greenland and Zaragoza, Spain, linking a system of Air Force installations which extended three quarters of the way around the world. SAC's offensive bomber force added five new bases within the U.S. in 1955-1956: Abilene, Texas; Homestead, Florida; Portsmouth, N.H.; Plattsburg, N.Y.; and Little Rock, Arkansas. Another was soon under construction at Burns Flat, Oklahoma.

Growing danger of a devastating air attack on the continental United States also exposed a need for more strategically located air defense bases. In 1955, Congress approved construction of six interceptor bases just below the Canadian border. By June 1957, five of these--located at Klamath Falls, Ore.; Glasgow, Mont.; Minot and Grand Forks, N.D.; and Marquette, Mich.--were in operation. The sixth, originally planned for Kalkaska, Mich., was delayed by the failure of Congress to agree on its location. The bases at Minot and Grand Forks supported a squadron of heavy bombers in addition to the interceptors. Construction began on two additional East coast bases in April 1955--at Goldsboro, N.C., and Myrtle Beach, S.C.

Typical of problems encountered in upgrading existing bases to the standards of Cold War defenses was runway pavement failure. During the period of feverish expansion after 1950, most runways and taxiways, particularly on bases not considered permanent, were built of flexible or asphalt pavement. Asphalt did not stand up as well as concrete built of portland cement, but even with the additional maintenance costs, asphalt was less expensive. On the refueling aprons and warm-up pads, however, asphalt always presented difficulties because spilled jet fuel caused it to disintegrate. As planes became heavier and the number of takeoffs and landings increased, asphalt pavement failures became more frequent. Finally, in early 1956, Headquarters USAF decided that all primary airfield pavement for combat or combat support aircraft would be of concrete made with portland cement. It also changed the design of heavy-load pavements to make them support greater weight, shock, and strain.

Challenges of defense against the threat of atomic weapons and their supersonic delivery systems also added to the lexicon of military installations such unlikely terms as the DEW Line, Texas towers, and SAGE buildings. The transformation of these concepts into physical entities is a story of rapid and radical expansion of the state-of-the-art of air facilities construction.

Limited use of search radars by the U.S. military dated back to World War II. Secretary of Defense Forrestal announced publicly in November 1947 that planning for a nationwide early warning system was underway. By the end of 1952 the United States was under the protective vigilance of a 75-station radar network. These were to be augmented with another 108 austerely-manned "mobile" stations and by some Canadian stations. The construction of these stations under the direction of the Army Corps of Engineers was often plagued by indecision as to siting and by the obstacles of building facilities on isolated mountaintop outposts. Frequently, conditions would require splitting the station into a radar facility at one location and a cantonment at another. But by 1955 the number of search radars in the U.S. had grown to 90. Plans included a network of radars across the Mid-Canada Line, roughly along the 55th parallel, and the Pinetree Line along the U.S.-Canada border. But it was the Distant Early Warning (DEW) Line that presented the most formidable challenge to the military defense construction program.

Across 3000 miles of the Arctic circle from Cape Lisburne, Alaska to Cape Dyer, Baffin Island the USAF and their contractors, Western Electric and the Bell System, erected a series of sites whose radar coverage overlapped to provide a continuous electronic warning shield against penetration by hostile aircraft. Conceived and built between 1952 and 1958, the DEW Line comprised three types of sites. The main stations provided a rotating

radar and a co-located complex of full service and support facilities. Secondary or auxiliary stations contained everything but complete service stations. The "gap fillers" were small sites mainly housing a non-rotating radar device.

Vagaries of temperatures from -65 degrees to +65 degrees Fahrenheit, and gale winds exceeding 100 mph characterized the climate over most of the DEW Line. The surface was a "muskeg," a sludgy marsh two to six feet in depth, frozen in winter and thawed in summer. The permafrost below it was perpetually frozen.

Site selection was made difficult by lack of accessibility and the absence of accurate maps. Prospective areas were evaluated around two principal criteria, the presence of a smooth area able to accommodate large C-124 cargo planes and an available gravel supply to provide a four to six foot thick surface on the landing strip.

Western Electric subcontracted to outside firms much of the design and construction work. Personnel with highly diversified building skills were hired, from geophysicists to riggers and from cooks to "ice inspectors." Supplies and equipment arrived initially by sea from the Port of Seattle; later airlift and land transportation were also used. Logistics for the project were of monumental proportions.

Structures housing personnel and radar equipment were developed, by experimentation, as simple, thoroughly functional modular units measuring

approximately 19 by 28 by 10 feet high. Precision-prefabricated, preinsulated panels, shipped from factories in the United States, were assembled in a heated area, linked together end-wise, and towed on skids over frozen trails to their permanent locations. Aligned into the prevailing winds, they were mounted on stilts sunk into the permafrost. They stood several feet above the ground, allowing the snow to blow under them. They were sturdily built to withstand 125 mph winds, two inch coatings of ice, and 30 pounds per square inch of snow.

First tested at a site on Barter Island, 240 miles north of the Arctic Circle, and in the farmlands of Illinois, construction of the DEW Line then moved generally west to east. It began at the old World War II Navy camp at Point Barrow, Alaska, whose existing landing strip and buildings made it an attractive starting point. The DEW Line construction was completed in July 1957. Nor did the DEW Line stop at the water's edge. With the help of the U.S. Navy its protection was extended seaward into both oceans by the use of radar-equipped aircraft and ships, and later Texas Towers.

Experience in building the $400 million DEW line produced not only a formidable defense complex but such "spin-offs" as basic research on the arctic polar cap, arctic survival methods, and the art of nourishing oneself on lichens, lemmings and sea cucumbers.

The USAF authorized the construction of five stationary offshore observation platforms in the autumn of 1953. They were called "Texas Towers,"

after similarly designed oil-drilling platforms in the Gulf of Mexico. The initial estimate of cost was $4,000,000 per copy, funded from FY 1954 and FY 1955 appropriations. Located about 100 miles into the Atlantic Ocean, the towers were equipped with radar detection devices to search out and identify approaching aircraft. In addition, the Navy was authorized facilities on the towers to house recording equipment for collecting oceanographic data.

Although the USAF monitored the project, the Navy's Bureau of Yards and Docks (BuDocks) supervised actual construction. The Air Force depot at Rome, N.Y. furnished technical assistance on radar matters.

First to be erected was Texas Tower No. 2 (TT-2), located on Georges Shoal, a shallow, treacherous area 110 miles east of Cape Cod. BuDocks arranged for site surveys, core drilling and the necessary feasibility studies in the summer of 1954. The Air Force identified the Bethlehem Steel Company as the prime contractor for TT-2, with the platforms to be fabricated at Bethlehem's Quincy, Massachusetts yard.

Though TT-2 was officially launched from the Quincy yard on 20 May 1955, it was not actually floated until two weeks later because of trouble in launching. On June 3, it was floated to another dock where temporary legs were installed and it was fitted for sea. It sailed for the site on July 12, arriving two days later. At the site, workmen dropped temporary legs to the shoal 55 feet down in order to jack the tower up. They raised

it until the bottom of the hull was 63 feet above water, its permanent position. Then the three permanent caissons, which were 10 feet in diamater and 185 feet in length, were sunk into the shoal to a depth of 48 feet. Inside each caisson they inserted a steel tube six feet in diameter running from the main deck down about 140 feet. This tube was to provide housing for utilities and connections for supply of fuel oil and fresh water. The space between the inner tube and the outer was filled with concrete. The lower 40 feet were filled entirely with concrete. An outer shell, 15 feet in diameter, was placed around the bottom 60 feet of each caisson and also filled with concrete.

Triangular in shape, the hull measured about 200 feet on each side. It was 20 feet deep, divided in the center to make three decks. The bottom deck was for storage tanks and pumps. The second deck contained living quarters, administrative offices, galley and mess hall, food storage, heating and ventilating equipment and power generating equipment. The top or main deck was kept clear of obstructions for use as a helicopter landing pad. Along the length of one of the 200-foot sides was a deckhouse or radome deck 12 feet high and 60 feet wide. In the center of the radome deck and raised about 28 feet was the search radar's antenna. Flanking this antenna at radome deck level, to avoid mutual electronic interference, were two other antennas. All radar operating equipment was housed in the space under the radome deck. The hull and its equipment weighed about

6,500 tons. The three-legged design was used to minimize the resistance to the tremendous force of the seas.

Beneficial occupancy passed to the Air Force on December 2, 1955. TT-2 became fully operational in April 1956.

Superstructures for TT-3 and TT-4 were configured, constructed and erected in much the same manner as TT-2. Begun in late 1955, these towers received USAF operational units in November 1956 and November 1957 respectively. TT-1 and TT-5, for which the need was not considered to be as pressing, were not undertaken at that time due to fund limitations, and in fact were never built. Actual construction costs of the towers (excluding equipment costs of approximately $2,817,000 each) were $12,373,350 for TT-2, $10,060,987 for TT-3, and $10,369,166 for TT-4.

Violent winds in January 1964 collapsed TT-4 and marked the beginning of the end of the Texas Tower program. TT-4, in contrast to TT-2, weighed 7,000 tons and stood in 185 feet of water. Each of its legs was 252 feet long and 12 1/2 feet in diameter. The overall height from the ocean floor to the top of the radomes was 345 feet, roughly equivalent to a 30 story building. Its underwater bracings were weakened by Hurricane Daisy in late 1958. Despite a series of repairs, TT-4 could not withstand the powerful storms of the following three winters, highlighted by the 132-mph winds and 50-foot waves of Hurricane Donna. TT-4 finally fell into the sea; 28 lives were lost. The Senate Committee on Armed Services conducted

an inquiry into the matter in May 1961. By January 1963 the remaining towers were inactivated, but not before performing a vital function in radar defenses of the United States.

Because of the increasing speed and complexity of hostile aircraft, radar and communications technology was called upon to augment other defense systems, such as the DEW line and the Texas Towers, with a high-speed digital computer network to receive, process and transmit air surveillance identification and weapons guidance information. Called the Semi-automatic Ground Environment system, or SAGE, it was made up of a series of Direction Centers and Combat Centers housing advanced electronic equipment, display consoles and communication gear. Testing began in late 1953. Computer refinement problems and a 1957 Defense Department in-depth review of all military construction programs caused some delays in the construction of the complex. The system became fully operational under the North American Air Defense Command in December 1961.

The SAGE "blockhouses" constructed during this period were erected on existing military installations wherever possible. Direction Centers were four-storied buildings, 150 feet square and approximately 75 feet high. An all-important power and air conditioning plant, measuring 110 feet square and 21 feet high, was built nearby and connected to the Center by a 22- by 100-foot bay. A fuel storage tank farm with 90,000-gallon capacity was also part of the complex. The smaller Combat Centers were

three storied, 150 foot square blockhouses with associated power plants and 60,000-gallon tank farms. Some Combat Centers were located adjacent to their parent Direction Center, thus saving personnel, equipment and construction costs.

Obtaining family housing for its officers and airmen at rentals they could afford continued to present difficulties for the Air Force in the Post-Korean era. In 1954 the Air Force needed at its semipermanent installations 185,000 housing units--160,000 in the United States, its territories, and possessions. It had only 64,000 units of all kinds available, including trailers and temporary housing. In the United States the Air Force depended on Title VIII of the National Housing Act (Wherry housing). Although never enough, Wherry housing helped relieve the shortage. But overseas and at isolated locations such as aircraft control and warning stations, building was difficult and shortages remained acute.

Congress passed the Capehart Amendment to Title VIII of the National Housing Act in August 1955. This amendment permitted expansion of Wherry housing by authorizing the use of quarters allowances of occupants to pay off the mortgages. The Air Force contracted for housing to be built on government land in the United States or its territories. The average cost of quarters was not to exceed $13,500 per unit. By June 1956, the

Air Force had drawn up plans to build more than 46,500 of these units at eighty-eight bases. In July, construction began on large developments at Dyess AFB, Tex., and Eglin AFB, Fla. Between July 1956 and May 1957 work started on 9,367 additional units on thirteen bases in the United States.

Besides the perennial housing situation, noise from jet aircraft was adversely affecting adjacent communities. General Earle E. Partridge in 1956 recognized this as a problem of national proportions. Technology was at work attempting to reduce engine noise. But the only immediate alternative to public acceptance of the inconvenience of overhead jets was a $3 billion relocation of certain affected installations, clearly prohibitive to an Air Force whose entire investment in air bases in 1957 was $7 billion. Fortunately, an understanding, civic-minded American public has relegated the noise problem to a note in the history of air installations.

Post-Korean defenses of the U.S. gained a new dimension when Russia's Sputnik ushered missiles and outer space to center stage. Demands of a space-oriented global defense system were soon reshaping the profile of U.S. air installations.

The Space Age, 1958-1963

Long range guided missile development in the U.S. dates from the combat debut of the German V-2 rocket in September 1944. During the following decade in the U.S., progress in research and development was substantial, but plagued by conservative, budget-balancing constraints common to new scientific endeavors. When the Soviet Sputnik punctuated space in 1957 the USAF was already proceeding with a fully approved and fully funded ballistic missile program. The Sputnik "spectacular" added a sense of urgency to the missile program and geared all effort toward speedily attaining "IOC" - initial operational capability. Dollars earmarked for guided missiles and their components had comprised nine per cent of the Air Force budget for procurement of aircraft and related items in FY 1954; by FY 1962 missiles were claiming 37.5 per cent of this budget. The concept of concurrency of development and production permitted base construction and site activation to proceed simultaneously with missile development and the organizing of support systems.

Training facilities for missile men were first established by the Air Force at Cooke Air Force Base, California,* to provide training in the new field of missile launching and operations. They took possession of 64,000 acres of the former Army camp, including seven miles of Pacific Ocean frontage. The Corps of Engineers began a $100 million construction program in 1957. Technical facilities included a guidance center,

*Redesignated Vandenberg AFB in 1958

an operations launch building, several launch pads, and missile maintenance buildings. The barracks area, worn from service in World War II and the Korean Conflict, was thoroughly rehabilitated. In addition, an $11 million, 800-unit Capehart housing project was undertaken. A strategic missile squadron was activated there in January 1958. Since then, this installation has been in the forefront of missile defenses. It is currently the only base from which operational test ICBM's are launched. More than 1200 of these missiles and polar orbiting space satellites have been launched from Vandenberg Air Force Base since 1958.

Survival was the paramount consideration in selecting and preparing sites to house operational missile units. Dispersal, reminiscent of earlier days, was the axiom of the missile age. The protection afforded by physically separating missile sites was augmented by the hardening of missile silos to withstand the shock of high megaton blasts from attacking enemy missiles or bombs. The construction of these complex facilities dominated the period from 1957 to 1964.

Sites were located in areas ranging from Malmstrom AFB, Montana with temperatures as low as -42 degrees to Davis-Monthan AFB, Arizona with +110 degrees, and from the 11-inch annual rainfall of Davis-Monthan to 47 inches at Little Rock, Arkansas. Some were near existing construction industries; others were isolated. By any measure the size of the task achieved in constructing the missile system was formidable. To build the missile sites underway or planned by 1961, the required excavation was

equivalent to a hole large and deep enough to stack the Great Pyramid of Gizeh and three other pyramids, leaving the tip 160 feet below ground level, or to dig a ditch 10 feet wide and 10 feet deep from Los Angeles to Pittsburgh. Materials used included 2,647,000 cubic feet of concrete, 66 million gallons of water, and 643,000 tons of steel. The combined area of the sites was approximately that of the state of Colorado. Among the first bases to receive operational missile units were Larson AFB, Washington; Lowry AFB, Colorado; Ellsworth AFB, S.D.; and Mountain Home AFB, Idaho (Titan missiles); and Francis E. Warren AFB, Wyo.; Vandenberg AFB, Cal.; Schilling AFB and Forbes AFB, Kans.; Offutt AFB and Lincoln AFB, Neb.; and Fairchild AFB, Washington (Atlas missiles).

Construction of the massive intercontinental ballistic missile facilities was marred by a series of strikes and work stoppages generated primarily by conflicting work provisions. These incidents affected such key installations as Warren and Lowry Air Force Bases. The national attention received by the stoppages and the efforts by both Congress and Kennedy Administration Labor relations agents to resolve the issues reflected the urgency of defensive missile activation plans.

Emphasizing the increasing interest and activity of the Air Force in missile matters, the research center at Holloman Air Force Base, N.M., was designated the Air Force Missile Development Center in September 1957. A test area for ground-to-air interceptor guided missiles was also established

in early 1956. Called the Air Force Missile Employment Facility, it was located at Eglin Air Force Base, Florida. Eglin was particularly well suited for this testing as it was the largest air base in the nation, with 465,000 acres of land and 17,500 square miles of overwater range in the Gulf of Mexico. The extension of the overwater test area to a point 375 miles into the Gulf created temporary problems regarding the use of the air space by commercial airlines. A third facility, the Air Force Missile Test Center with headquarters at Patrick Air Force Base in Florida was used to test ballistic and cruise missiles. Its ranges extended from the East Coast of Florida more than 5000 miles into the South Atlantic. Besides the main base at Patrick, there were a launch area at Cape Canaveral 15 miles to the north and 12 tracking stations linking the vast ocean range.

These varying kinds of facilities illustrate the extent to which the Air Force was involved in missile operations by the early 1960's. They required the construction and maintenance of launch pads, fuel storage areas, telemetry stations, computerized data reduction and technical laboratory buildings, and auxiliary airfields as well as the usual office space and living quarters. Much of the construction during the period preceding the Viet Nam Conflict was in support of the Air Force's role in the missile age.

Vietnam to the Present, 1964-

Involvement of the USAF in open aerial warfare in Southeast Asia dominated the air installations picture in the mid-1960's. The rapid build-up of the war created an immediate need for a number of new, jet-capable airfields in Vietnam. Typical of these was the field at Cam Ranh Bay. The task of building the base was levied in June 1965. Starting from scratch in mid-August, engineers had to have interim facilities ready to receive operational aircraft by November 1965, and permanent facilities in place by the following summer. Cam Ranh Bay was on a remote sand penninsula in a primitive area. It was in a zone of open hostilities, sniping and sabotage. There was no laterite or other subgrade material for constructing the airstrip. Lumber was in critical supply, and often exotic Philippine mahogany plywood was used as form lumber in pouring concrete. Deep sand and intense heat added to the problems of the construction workers. Labor was provided by an American contractor, with frequent assists from military personnel.

Heavy reliance was placed on "instant construction"--new concepts of using prefabricated materials and structures for both interim and "permanent" facilities. The Air Force developed a pre-packaged 1100-man "tent city" deployment kit called the "Grey Eagle Kit." This complex housed advanced party personnel and supported initial aircraft operations. Although readily available and quick to erect, the kit was not designed for continued use. The two kits initially erected at Cam Ranh Bay were later replaced with Quonsets and newly developed inflatable shelters.

Inflatable shelters were rubberized plastic shells. When inflated they provided weatherproof, corrosion-proof shelters. Two types--the single wall and the double wall--were used at Cam Ranh Bay. The single walled unit, used for warehousing, measured 45 feet by 60, 90, 120, or 150 feet. It was kept inflated by small electric-driven blowers that maintained an overpressure within the shelter. For office and maintenance areas the double walled shelter was used. Its interior dimensions were 48 feet by 60, 96, 120 or 144 feet. In contrast to the wholly inflatable single walled unit, only the space between the two walls was inflated. Cam Ranh Bay was the first base to put inflatable shelters to operational use.

The urgent need in Vietnam for runways capable of handling jet combat and cargo aircraft could not tolerate the time-consuming process of placing concrete pavement. The familiar PSP, so extensively used on the Korean penninsula, was ill-suited to the heavier jet aircraft and the unstable soil conditions. An extruded aluminum plank, called AM-2, was developed as a temporary expedient for the Southeast Asia environment. Measuring 2 by 12 feet or 6 by 12 feet, it had interlocking and keyed joints. Fitting them loosely together facilitated placement and removal of the mats and allowed for the thermal expansion caused by 100° temperature changes. The mats weighed six pounds per square foot. The smaller mats could easily be placed by two men. A non-skid ferrox coating was factory-applied to the

wearing surface. The mats could be laid on undisturbed earth after necessary grading and leveling. The AM-2 mats were used for entire runways, including the 10,000- by 102-foot runways at Cam Ranh Bay and Phan Rang air bases.

Experience rapidly exposed both the strengths and the weaknesses of AM-2. In general, they far exceeded the projected life of 2000 takeoff and landing cycles. But the mats shifted under traffic, developed lateral bowing, and lost much of their anti-skid material in areas of heavy traffic and turning. Subgrade voids caused the rupture of some end joints. In an effort to stabilize the subgrade soil, engineers laid membranes beneath the AM-2 to prevent penetration of surface water. But membranes ruptured and dissolved as a result of jet fuel spillage.

Engineers also attempted to fill undermined areas as a repair measure. As they gained experience in the use of AM-2, they gave more attention to providing an original stabilized subsurface, using slopes to facilitate drainage, alternating traffic patterns, and anchoring mats at predetermined intervals. An improved membrane, T-17, was developed. It could be installed quickly and provided a durable, waterproof, dustproof surface. When placed on a well-compacted, crowned subgrade, properly joined and anchored and afforded adequate shoulder drainage, it was one of the most effective new materials for fast airfield construction to come out of the war in Vietnam. The years of combat operations, however, took their toll.

Officials examined the AM-2 on hand in 1970 and decided that it would not be worth rehabilitating the AM-2 in use in Southeast Asia after hostilities were concluded or storing servicable mats for a future contingency. Immediate needs for landing docks for the giant C-5 cargo plane and for some tactical areas were filled; the rest was scheduled for disposition in Southeast Asia.

Navy's Bureau of Yards and Docks (BuDocks) was the design and construction agency in the Southeast Asia theater. The Air Force regional civil engineers, one in Bangkok and one in Saigon, were co-located with their Navy counterparts. Close day-to-day contacts facilitated the myriad decisions on changes, design interpretations, and application of criteria which attended the construction of war zone installations. Contracting procedures were expedited and simplified by use of a cost-plus-fixed-fee system. The design agency issued a letter notice to proceed on a $5 to $15 million increment of construction work for an agreed estimated construction cost. A fee of three to four per cent was negotiated on the total estimated cost. Overruns of construction cost were borne by the government and savings on underruns credited to the government, but the contractor's fee remained fixed. The contractor initially placed purchase orders on long lead-time and bulk items such as cement and reinforcing steel. As soon as siting was firm and preliminary plans available, he started full scale construction.

Substantial benefits accrued to the government from the use of this procedure. Much of the time needed for contract preparation, advertising and auditing was saved. The government retained sufficient flexibility to revise work and redistribute the work force as rapidly changing circumstances dictated. Control of funds was maintained through continuous audit. The government, by assuming liability for work and supplies, avoided high-cost war risk insurance.

Several new air bases in the Southeast Asia theater of operations were constructed under these organizational and contracting arrangements as the build-up of forces progressed into the 1966-67 period. The creation of Tuy Hoa Air Base, 70 miles north of Cam Ranh Bay, was especially interesting, however, in that it involved a new and untried management concept of installation construction. Under a project called Turn Key, the Air Force administered a contract giving to a single contractor the responsibility for constructing the entire installation. The Air Force Logistics Command competitively selected the contractor who then signed a letter contract in May 1966. Construction began in August. Except for real estate acquisition and security measures, the contractor furnished everything needed to build the base--designs, engineering, transportation, materials, equipment, the labor force and the actual construction. He was prohibited from using existing facilities, so he had to construct his own port area to bring incoming supplies and equipment ashore. Construction moved rapidly. The first combat airmen arrived three months later. With only

minor deviations and exceptions to contract provisions, the builder completed the project in mid-1967, proving the viability of the approach.

Although the Air Force in early 1969 began projecting a decrease in needed construction in Vietnam, other projects continued to go forward in Thailand, Okinawa, Taiwan and Korea. Officials set March 1971 as the scheduled phase-out for the work force of Raymond, Morrison-Knudsen/Brown & Root, Jones, the construction combine which was the prime civilian contractor in Vietnam, and planned the eventual closure of many of the operational sites there. The full story of the building of air installations in Vietnam remains to be told. But it is certain to highlight the vital role of military and civilian engineers and builders and the sheer magnitude of the more than $400 million in construction which they accomplished.

Demands of the Vietnam War generated some interesting new ways of using the civil engineering resources of the Air Force. In 1965 Rapid Engineering Deployment and Heavy Operational Repair Squadrons, Engineering (RED HORSE) were formed. Their primary mission was to make emergency repairs to airfields damaged by enemy action or natural disasters. Since the building of new air bases in Southeast Asia was the responsibility of the Navy and the Army, RED HORSE units were not primarily tasked and trained to construct new air fields, but they did possess a collateral capability in this area. RED HORSE units were activated in the United States

received extensive training and preparation at Cannon Air Force Base, N.M. and Forbes Air Force Base, Kansas, and began to deploy to Vietnam in early 1966. Almost immediately after arrival at the four jet-capable airfields under construction, RED HORSE squadrons, through dire necessity, were engaged to use their "collateral" talents for air base construction. For example, at Phan Rang Air Base they were tasked with maintaining in operational condition the AM-2 interim runways which were already being undermined by torrential rains. And at Phu Cat a shortage of approved construction funds in late 1966 curtailed contractor-built vertical construction, which was taken over by the newly arrived RED HORSE squadron.

The Vietnam War gave birth to yet another innovation in Air Force civil engineering support - the operation of mobile teams capable of responding on short notice to tactical and special warfare requirements. The Base Engineering Emergency Force, known by the combination nickname and acronym Prime BEEF, was conceived in 1963. Operating commands organized teams of specialists to erect aircraft revetments and cantonments complete with electricity and running water. The first three teams deployed from the United States and arrived at Saigon's Tan Son Nhut Air Base in August 1965 for assignment to tasks at Ton Son Nhut, Da Nang and Bien Hoa Air Bases. During their four month stay the three teams erected over 12,000 linear feet of revetments. Subsequent teams carried on this excellent beginning, accomplishing a wide variety of general construction projects

under very demanding conditions. By July 1966, less than a year after the arrival of the first contingent, 26 Prime BEEF teams had deployed to Vietnam and 12 to Thailand for four-month "temporary duty" tours.

RED HORSE and Prime BEEF teams remain an active component of Air Force construction. In 1970, for example, a 13-man Prime BEEF team deployed to the Trust Territory of the Pacific (Micronesia) in support of a civic action program. They were engaged in constructing a dispensary, building water catchments and bridges, upgrading runway roadways and constructing other facilities. The Office of the Joint Chiefs of Staff later considered further expansion of the Prime BEEF program based on requests from the U.S. Department of the Interior for help similar to that given in Micronesia.

Military construction programs in the Vietnam era involved far more than support of combat operations in Southeast Asia. Funds were spent on construction and expansion of facilities in other parts of the world to maintain an effective response to ever-changing global defense requirements. Space systems, missile sites, satellite programs and radar warning complexes were established and improved. Research and development activity involved exotic new aircraft such as the Mach-3 SR-71, vast computer hardware, intricate electronics systems and nuclear test facilities. Physical plants at training institutions like the Air Force Academy and Officer Training School were continually modernized.

Operational requirements ranged from dispersal of fighter aircraft to foreign military assistance to perfecting a worldwide communication network. All of these efforts required a wide variety of skills and talents and substantial outlays of construction funds.

In the competition for federal funds for military construction, Congress generally required detailed justification of proposed projects on a case-by-case basis. And superimposed on annual budget formulations were occasional broad policy changes. In 1964 and 1970 the Defense Department ordered far-reaching base closure actions, which involved not only real property disposals but relocation of military units and modification of existing active installations. In October 1967 the Department of Defense imposed a freeze on military construction programs. Only Southeast Asia-supported projects and new weapons system developments were allowed to proceed. The freeze affected $140 million of construction funds in FYs 1967 and 1968. Again in September 1969 President Nixon directed a blanket 75% reduction in federal construction, resulting in a deferral of $146 million in Air Force construction monies. Foreign exchange expenditure limitations (gold flow) imposed additional constraints on the use of available dollars for oversea procurements.

Real property acquisitions and dispositions since the mid-1960's has shown a trend toward a reduction in Air Force holdings. Changing requirements made it necessary for the Air Force to continue to purchase real property at various times for such purposes as runway extension, family

housing sites, Minuteman missile complexes and facilities expansions. At the same time, installations that were no longer needed were deactivated. The Department of Defense in 1964 directed the closure of a long list of bases and stations, including many radar sites and associated family housing areas. The Atlas and Titan missile sites, replaced by the more advanced Minutman missile systems, were also committed to disposal or converted to other, non-critical uses. By the end of 1968, 110 such obsolete missile sites had been released. Base closure action also affected all or part of such major bases as Larson Air Force Base, Washington; Stead Air Force Base, Nevada; Lincoln Air Force Base, Nebraska; Brookley Air Force Base, Alabama; and Amarillo and Connally Air Force Bases in Texas. In Europe, the USAF released 64 of 67 installations in France at that government's request in April 1967; the remaining bases were temporarily retained.

Surplus real property holdings in the United States were put to a variety of uses. Excess family housing complexes were made available to municipalities for use as low income housing projects and to universities for student housing. James Connally Air Force Base, Texas, for example, was deeded to the state for use by Texas A&M. Another utilization of surplus housing was as living quarters for families of servicemen on oversea (unaccompanied) assignments. In January 1966 a pilot program was begun with 735 housing units at Schilling Air Force Base, Kansas, which had been closed in 1964. The Air Force reassumed accountability for the housing complex.

Although they were later transferred to the Army's jurisdiction, these Capehart housing units are still being used by Army, Navy, and Air Force families while their husbands and fathers are stationed overseas. Other inactive bases were put to similar use. Obsolete missile launch complexes were converted to Civil Defense facilities, college laboratories, and other useful facilities.

Putting inactive facilities to good use was well demonstrated in a case involving a research area in New Mexico. The Surgeon General decided to terminate the operation of a primate farm at Holloman Air Force Base where studies had been underway on the effects upon chimpanzees of the stresses encountered by astronauts during space flights. The Albany Medical College in New York, believing that the continued existence of the farm was highly desirable, agreed to take over its operation. The Air Force then outleased approximately 37 acres of land, seven medical buildings, personal property, and about 160 chimpanzees to the medical college for a 15-year period.

Municipalities voiced a growing desire in the early 1970's to annex military bases lying adjacent to their city limits. Although not all annexation requests were approved, there have been some successes. Dover Air Force Base (excluding the housing area) was annexed to the City of Dover, Delaware and Nellis Air Force Base, Nevada was made a part of the City of North Las Vegas.

Pressures from escalating Southeast Asia expenditures were evident in the family housing construction programs during the 1960's, as programs were stretched out or postponed. Release of the FY 1966 program was deferred by Congress from July 1965 until January 1967. No program was ever submitted for FY 1967 funding. Subsequent yearly programs for new family housing, improvements, and minor construction projects experienced deferrals, "holds," and close financial and budgetary controls. In late 1968 a sizable family housing deficit again was evident throughout the Air Force. To overcome this serious shortage, the Air Force requested 10,860 new units for FY 1970; the Secretary of Defense approved 1850; the Congress eventually funded only 1650 units. Although the following years saw a slight increase in authorized units (2800 in FY 1971; 3600 in FY 1972; 3168 in FY 1973), the problem continued to be a serious one for Air Force planners and servicemen alike.

One dominant trend emerging from this critical situation was the remarkable development of relocatable and modular housing. The first program was at Clark Air Base in the Philippines, a vital staging area for the Vietnam operations. Neither "mobile homes" nor "trailers," the Air Force-designed relocatable houses erected at Clark were transportable package homes that provided approximately 1080 square feet of conventional living area. Designed for commercial assembly line manufacture, each unit became a 26- by 45-foot, fully air conditioned, completely insulated, three

bedroom, 1 1/2 bath, single-family home equipped with electric range, refrigerator, automatic washer, dryer, and water heater. It had hinged roof and wall sections that permitted folding the whole unit including the electrical appliances into a transportable core approximately 10 feet wide, 11 feet high and 48 feet long. Aluminum siding with baked-on enamel finish and sliding aluminum windows comprised the exterior finish for this laminated wood frame structure. Roof sections, outside wall sections, and the floor were laminated wood frame with four-inch thick vapor-sealed insulation. The interior of the outside walls was finished with gypsum board. Partition walls and the roof interior were finished with plywood--painted for ceilings and mahogany veneered for partitions. The units were erected on concrete piers and then connected to utility systems.

Contracts for site preparation, consisting of roads, walks, foundation piers, utility connections and landscaping, were handled by the Navy. In a 7000-mile land and water trip in early 1964, 270 housing packages, each weighing 17-18 tons, were shipped from California to Manila on aircraft carriers, then by commercial transportation to Clark Air Base. Upon arrival, the folded packages were positioned on the foundation piers. Touch-up repair of shipping damage and connection of utility systems were completed by a crew of 10 men in four hours per unit. During January 1964 all houses were accepted for occupancy.

In mid-1964, 773 additional units were delivered and erected at 10 other locations including missile sites in the U.S. A follow-on purchase of 782 units (later increased to 800) was funded under the FY 1964 military construction program. These units were larger and of improved design. The program continued to demonstrate success. The considerable reduction in foreign exchange resulting from delivery and erection with little outside help added to its attractiveness. The FY 1965 program expanded the design further to include two-storied units that could be set up in duplex, four-plex, or six-plex configurations. Although the Air Force continued to act as the purchasing agent, units were acquired for other military services as well, and were used in many areas, especially remote sites such as Alaska, Laborador and the West Indies.

Nor was family housing the only beneficiary of the concept of relocatable structures. Its technology was also directed toward the need for relocatable buildings which could be used for peak periods of rapid troop build-up in the United States, Southeast Asia and elsewhere. The Air Force's Directorate of Civil Engineering initiated a plan to develop a two-storied, 80-man dormitory that would be modest in scale, truly relocatable, of domestic manufacture, quickly procurable, easily erected by Prime BEEF or RED HORSE forces, and easily dismantled and repackaged for shipment and use elsewhere. A test project was initiated. An Air Force selection board chose from

93 bids three of the most satisfactory proposals. A pilot program of fourteen 44-man dormatories at Nellis Air Force Base, Nevada was undertaken, and successfully completed in June 1967. The Air Force Chief of Staff then approved the modular relocatable troop accommodation concept for further exploitation, and design criteria were established for use in follow-on procurements.

This technology had been successfully applied by 1971 to training facilities, dining halls, elementary and high school classrooms, hospitals, airfield control towers, crew quarters, and chapels. The portability of these structures was demonstrated when units were moved to Korea in response to the Pueblo incident. Other structures were relocated in Turkey, Crete and at various sites in the Pacific and United States as changing requirements demanded. In a variation of normal procedures, the Air Force contracted with civilian firms in 1968 to move 200 relocatable housing units 800 miles from Glasgow Air Force Base, Montana to Mountain Home Air Force Base in Idaho. In this and many similar instances the worth and wisdom of the relocatable structures concept was repeatedly proven.

Performance criteria for Air Force family housing in recent years continued to emphasize modular construction with relocatable features, fully utilizing industrial methods in their fabrication.

Variations in procedural methods evolved as the construction of both conventional, fixed-in-place family housing and the modular relocatable

units proceeded in parallel. As alternative concepts of building management, each system had distinct characteristics. By late 1969, Air Force civil engineers were dealing with four discrete methods of housing design and construction.

Folio Designs: Conventional Department of Defense family housing packages.

Site Adaptation: Beginning with successful designs, builders adapted them to the geographic requirements of the new location. This represented a considerable reduction in architectural and engineering costs.

Turnkey: Modeled after the Turnkey concept used to construct Tuy Hoa Air Base in Vietnam, this approach involved using private capital to develop stateside housing. In a two-step contracting procedure, builders first submitted proposals using familiar construction methods and building materials of their own choosing. The Air Force evaluated the proposals. Contractors then were invited to submit firm bids on acceptable proposals. The Air Force accepted the lowest responsible bid.

Optimum Design: This computer-based system provided a complete, life-cycle cost analysis (construction costs plus follow-on operations and maintenance costs) using various methods and proven satisfactory materials. The designer could then choose the "optimum" design that would provide overall economies to the government.

Along with expansion of contracting and management procedures came other new applications and innovations in military family housing. Low density sites were laid out utilizing duplexes and single storied units in place of some row- and two-storied units. Reducing the number of dwellings per acre markedly improved living conditions in Air Force housing areas. The long-standing need for temporary lodging for newly arrived military families was partially met by the development of very popular motel-like units complete with kitchenettes. In 1970 the Air Force Welfare Fund issued a grant for $10.73 million to fund the construction of 1020 motel units at 24 installations. Mobile home parks were also substantially upgraded as more and more servicemen met increasing housing costs by using mobile homes as permanent quarters. Some government-owned trailers, excess to the Minuteman missile program, were pressed into service to relieve serious family housing needs at bases such as Holloman in New Mexico. The Air Force also worked closely with the Department of Housing and Urban Development to provide military housing to low income servicemen and women and to coordinate national policy regarding homeowner assistance.

Decades-old, persistent family housing problems of the Air Force continued to concern planners at all levels of air operations. The concerted efforts of government and industry to cope with these problems consumed

immeasurable time and treasure. It was a successful effort. In 1974, Mr. Perry J. Fliakas of the Defense Department's Installations and Logistics staff anticipated future reductions in family housing construction, stating, "We've turned the corner on our family housing deficit." These words implied that although housing problems remain, the battle was being won.

These events in oversea and stateside operations, facilities construction and real property activities illustrate but by no means encompass the totality of air installations and related construction during the years of the Vietnam conflict and the first months of the post-Vietnam era. Maintenance of facilities and real property was hardly mentioned. Budgetary and inventory statistics were purposely avoided. But the recent past was prologue to the decades to come. It is easy to see from the foregoing that the Air Force was dynamic, sensitive to changing requirements, and open to innovative concepts and methods to create the bases and buildings necessary to keep the air arm of the U.S. second to none, whatever challenges the future might bring.

Humanitarian, Environmental and Civic Actions

Development and maintenance of the nation's airborne defense establishment since the turn of the century was a public work of the first magnitude. There was, however, a long list of defense-related activities which comprised a secondary public works endeavor, a by-product as it were of the taxpayers' defense dollars. The air forces of the United States were active in civic actions from the earliest years of aviation. In addition, air installations and civilian communities lived as neighbors which redounded to the mutual benefit of both. And of more recent vintage was the positive effort by the U.S. Air Force to join the battle for environmental protection and improvement. Following are a few illustrative examples of each of these "secondary" types of public works.

Military civic action was defined as "the use of military forces on projects useful to the local population at all levels in such fields as education, training, public works, agriculture, transportation, communications, health, sanitation and others contributing to economic and social development." This modern concept of civic action was crystallized in President Kennedy's foreign policy message to Congress in 1961, when he spoke of "the use of military forces in less developed countries in the construction of public works and other activities helpful to economic development." The history of the nation's air arm was replete with instances of civic actions both at home and abroad. Conditions frequently arose which required the kinds of assistance best offered by the capabilities

of aviation technology and the speed and freedom of aerial navigation. Since the primary mission of the air force is the nation's defense many cases of civic action have arisen in the context of a temporary, non-military crisis or emergency situation. One of the earliest civic activities was the assistance given to the Post Office by the War Department in inaugurating air mail service in 1918. Subsequent civic action projects included flood relief, mercy flights, border and fire patrols, insecticide and reforestation flights, and aerial surveys. Early aviators even used military ordnance in civic action. For example, bombs were dropped to break up threatening ice jams on the Susquehanna River (1922) and the Platte River (1924). And in December 1935 aerial bombardment diverted the lava flow of the erupting Mauna Loa volcano away from the waterworks in Hilo, Hawaii. Because the Army and the Navy were traditionally and legally charged with the accomplishment of military public works programs, the Air Force's contemporary civic actions tended to be mainly humanitarian. The Berlin Airlift, known as Operation VITTLES, in 1948-1949 and Operation SAFE HAVEN which evacuated thousands of refugees from Hungary in 1956-1957, were perhaps the most visible of hundreds of life-saving missions flown in recent years. The Air Force, often joined by other services, Reserve, and National Guard forces, continued to respond to such emergencies as Hurricane Camille in 1969 and the nine-state tornado disaster of April 1974.

Interaction between the nation's civilian municipalities and towns and its military airmen is as old as aviation itself. In the days prior to World War I, when cross-country flights in the South and Southwest were a matter of common occurrence, communities located under the air lanes used by Army fliers vied with one another in providing hospitality to transient aviators. One town sent out the following card to airmen:

> Upon presentation of this card, all courtesies will be offered you, including shower and pool baths at the Y.M.C.A.'s $87,000 plant, Country Club's $75,000 plant, Elks Club $47,000 plant. Coffee and sandwiches will be handed out by the Red Cross Canteens; hair cut, shave and shine given free at any barber shop; cold drinks at the soda water fountain, also local carfare.

Effects of an air base on the neighboring communities were extensive, ranging from economic impact to educational, social and cultural exchanges. This complex interaction can best be depicted by looking briefly at one such installation. Luke Air Force Base in Arizona has been in operation since 1941. Along with its Gila Bend gunnery range to the south, Luke covered nearly three million acres, the largest fighter training base in the free world. The following calendar year 1973 data illustrated its relationship to the surrounding communities, including Phoenix, Tempe and Scottsdale.

Annual contribution to the local economy:		$88,000,000
Annual payrolls:		$77,525,200
Military:	$56,229,700	
Civil Service:	12,055,800	
Other:	7,989,700	
Public contract awards:		$17,274,200
To firms in Arizona:	$11,274,000	
To firms outside Arizona:	6,000,200	
Population: (total affiliated with Luke)		21,522
Military employees:	5,652	
Civil Service:	1,084	
Contractor and others:	1,282	
Dependents:	13,504	

Some interesting facts (calendar year 1973):

The base relied on the local communities for 57% of its housing needs.

Over $300,000 was contributed to local charities and churches.

Local schools received $922,200 in federal aid for Luke school children.

Local colleges and universities enrolled 2,533 military employees, representing a dollar outflow of $51,840.

To maintain their standard of living, Luke employees spent over $60 million in the Phoenix area for food, housing, transportation, clothing and personal care, medical and dental care, and miscellaneous purchases.

Operating and maintenance expenses on Luke Air Force Base (including minor construction and repairs) totalled $34,530,400.

There were 11,276 retired military employees living in the vicinity of Luke, They received $56,226,900 in retired pay.

Community relations projects in which Luke employees participated included:

Youth camps

Alchoholic Rehabilitation Center

Providing busses to various local activities

Band concerts

Blood drives

Acting as counselors for retarded children's camps

Support to local hospitals

Providing base tours

Mutual aid fire fighting and prevention programs

MAJOR CONSTRUCTION PROJECTS:

	Ground Control Approach Facility	$ 337,100
	Bowling Alley	306,300
	Repaired Runway (Gila Bend)	287,100
COMPLETED	Banking Facility (Privately Owned)	250,000
IN 1973	Engine Run-Up Area	208,000
	Family Housing Roofs (Repaired)	143,000
	Radar Support Facility	108,000
	Maintain Runway (Luke AFB)	106,200
	Water Well (Gila Bend)	81,900
	TOTAL	$ 1,827,600
	Medical Facility	7,531,000
	Base Commissary	1,064,000
UNDER	Flight Simulator Facility	822,900
CONSTRUCTION	Squadron Operations Building	696,500
	Field Training Detachment Facility	598,800
	Flight Simulator Addition	284,900
	TOTAL	$10,998,100

MAJOR CONSTRUCTION PROJECTS: (Cont)

Base Exchange

Two Officer Dormitories

Repair to Runway & Taxiways

Theatre

PLANNED Weapons & Release Shop

Missile Assembly Facility

Child Care Center

Power Check Pad

Aircraft Engine Shop

This picture illustrates that Luke Air Force base was of much more value to the citizens of the Phoenix area than its $534 million assets in land, buildings and aircraft. Similarly, U.S. air bases throughout the world functioned as dynamic public works in constant interaction with the public whose liberties they served to protect.

Any story of public works and air installations would be incomplete without mention of the contemporary involvement of the Air Force in environmental protection and improvement. Echoing a growing public sensitivity to the preservation of our nation's natural resources, the USAF initiated a land utilization policy in 1967. It encouraged better utilization of semi-improved areas, especially large land holdings such as weapons ranges, for agriculture, grazing, and recreational purposes. Attention was also focused on timber production and wildlife conservation in these areas. The passage of the National Environmental Policy Act in 1969 and the establishment of the Council on Environmental Quality institutionalized much of the Air Force's environmental activities. Current active projects included air and water polution abatement, noise problems, climatic impact of stratospheric flight, pests and pesticides, waste recycling and disposal, and flight hazards from migratory birds. The continuing use of environmental impact studies insured that present and future developments would proceed in concert with the long range interests of the nation.

Five U.S. Air Installations

Stories of five individual installations depict in greater detail some of the interesting and often human facets of the history of air installations which are necessarily brushed over lightly in a general chronological account. Although the development of each U.S. air base is a unique story, these five are fairly representative of various types of installations dotting the preceding chapters. Kelly Air Force Base, Texas is the story of the evolution of a base from the earliest pioneer days of aviation, through the rigors of World War II combat training, to the demands of a modern automated supply center. Richards-Gebaur Air Force Base, Missouri is a product of the frantic base build-up of World War II--a base which survived the initial days as a make-shift auxiliary air strip to become the hub of the Air Force's global communications network. Albrook Air Force Base in the Panama Canal Zone is an example of military construction in the tropics. Francis E. Warren Air Force Base, Wyoming is a "muskets-to-missiles" saga beginning with Lincoln's frontier army and persisting into the very center of the space age. Finally, the Air Force Academy, Colorado stands as an example of the establishment of a relatively new installation, erected "from scratch" in the breathtaking mountains of Colorado.

Kelly Air Force Base

Kelly Air Force Base, Texas, located five miles from the center of San Antonio and partially within its southwestern limits, has the distinction of being the first military installation that the U.S. Army constructed in Texas for use specifically as an air base.

It was named in honor of Second Lieutenant George E. M. Kelly, who was killed on May 10, 1911, while landing his Curtiss pusher biplane, Signal Corps No. 2, on a street of the encampment at Fort Sam Houston, San Antonio. He thereby became the first U.S. Army officer to lose his life while piloting a military aircraft.

With the War Department's authorization to the Army's Southern Department on January 11, 1917 to lease land near San Antonio for aviation purposes, the story of Kelly Air Force Base began. A 707-acre site in South San Antonio was selected by Captain Benjamin D. Foulois, Southern Department Aviation Officer, for use in organizing, equipping, and maintaining aviation units for the Southern Department. On January 20, payment of $11,924.26 as first year's rental was authorized by the War Department.

Construction of the aviation camp began on March 6, 1917 and continued until the following September. March 10, 1917 saw Captain Foulois contract with Mr. E. Koerner for the clearing, grubbing, filling, and rolling of the site to prepare it for aviation purposes. In addition, soldiers from Fort

Sam Houston were sent to clear the land and cut grass. Two weeks later Mr. George A. Williams began construction of the foundations for hangars 1 through 6 in the area known later as Kelly Field No. 1. At the same time, Mr. Koerner signed a contract to build the superstructures of the six hangars. Construction was supervised by Mr. Williams.

Four airplanes, which shortly before had taken off from the old Remount Station at Camp Travis, San Antonio, landed in a cotton field in the Kelly Field No. 1 area, on April 9, 1917. Here, canvas hangars were ready for them.

Men of the 3d Aero Squadron arrived from Fort Sam Houston nearly a month later, on May 7 (a day celebrated as Kelly Day since 1951), to select a camp site on the aviation field. By mid-May, 4,500 to 5,000 soldiers and civilian construction workers were living in tents at the site. Construction was well underway on temporary wooden hangars, barracks, mess halls, officers' quarters, warehouses, machine shops, and other facilities needed to make Kelly an effective recruit reception center and aviation camp.

Before May had ended the 5th Aero Squadron had been organized at the camp and would remain there until the following spring. In June the 8th, 9th, and 10th Aero Squadrons were also formed at the camp, only to move elsewhere in July. These were the first of many units to be organized at Kelly and to serve at other fields.

Originally the aviation camp was to have been developed into four separate fields, but only Kelly Fields No. 1 and No. 2 were developed and used. The adjacent leased lands which would have been Kelly Fields No. 3 and No. 4 were released in the fall of 1917 after visiting Allied aviators had pointed out the dangers of having such large flying fields so close together.

Additional acreage, known as Kelly Field No. 2, was leased from the San Antonio Chamber of Commerce in July 1917, and joined to the original Field No. 1 tract. On March 13, 1925 Field No. 1 was redesignated Duncan Field in honor of Major Thomas Duncan who died in a crash at Bolling Field on May 25, 1923. Nearly 20 years later Duncan Field and Kelly Field (the former No. 2) were merged and called Kelly Field. Redesignation as Kelly Air Force Base occurred on January 29, 1948.

Construction work at Kelly Field No. 2 (later known also as the Flying Department) was started about July 24, 1917 by the Stone and Webster Corporation. Two months later the contractors turned over to the government a completed 12-squadron camp at Field No. 2.

Flying instructions were begun on August 11, generally regarded as the day when Kelly Field was officially opened. This followed the arrival five days earlier of 11 student officers, graduates of the aviation ground school at the University of Texas at Austin.

Kelly Field became in the following months of World War I the largest flying field in the U.S. Thousands of recruits were received in its aviation "concentration camp" (reception center), tested for 53 trade skills, and organized into new aero squadrons specializing in construction, repair, or supply (Field No. 1). Hundreds of pilots were trained to fly in eight weeks of school. Still others learned to instruct new students to fly (Fields No. 1 and No. 2). Adjutants and supply and engineer officers attended the "Father of Ground Schools" (Field No. 1). Large numbers of enlisted men became experts in the infant career field of aircraft and engine mechanics.

Advanced flying training school opened at Field No. 2, in January 1918, and 593 primary students then were training at Field No. 1. By October 1918 the number of cadets in flying training had fallen to 363. Up to the Armistice on November 11, the primary school had turned out 1,459 officer aviators and the advanced school at Field No. 2 had qualified 298 pilots as flying instructors.

Assistant Secretary of War, William M. Ingraham on October 12, 1917, approved purchase Kelly Field No. 1--its lands had been leased the previous January by Captain Foulois--with $156,224.17 of Signal corps funds. Deeds for the 717.17 acres were filed between February 9 and July 18, 1918. In 1919 Kelly Field No. 2 was also purchased.

Between World Wars I and II Kelly Field became noted for its advanced training of U.S. military pilots. The Air Service Advanced Flying School was officially established on June 28, 1922, and on September 30, Kelly was designated as a permanent military flying field. From July 7, 1922 to December 30, 1940, 3,945 pilots were graduated from Kelly's advanced school.

Other schools augmented Kelly's primary mission of advanced flying training. The Air Service Mechanics School was located there until 1921. A navigation school was added in August 1941, followed shortly by a Replacement Training Center and an Aircrew Reception Center. These Centers were later consolidated and moved to nearby Lackland Field. In 1942, two-engine aircraft were added to Kelly's inventory for training students and instructors, and pilots of England's Royal Air Force.

Steady expansion of training activities at Kelly and of the maintenance and supply depot at adjacent Duncan Field had become so great that by 1942 it was necessary to transfer to other locations the flying training facilities--easier to move than those of the depot. On March 11, 1943, Kelly and Duncan Fields were combined into one Army Air Forces installation designated Kelly Field. Flying training at Kelly finally ended on March 17, 1943, following the movement of the advanced single-engine and twin-engine flying training to nearby Randolph Field.

With the merger of Kelly and Duncan Fields into a larger base, Kelly's primary role was that of an air depot. During more than 30 years of service, development, and construction, the present San Antonio Air Logistics Center at Kelly has become a huge industrial-type establishment which specializes in the repair of aircraft, engines, and accessories, shipping these on short notice to Air Force organizations throughout the world.

Kelly's role as an air logistics center began on September 25, 1917, when the Aviation Section of the Signal Corps Depot moved from San Antonio to a warehouse on Kelly Field No. 1. An Aviation Central Supply Depot was also established at the field. The Supply Depot had only $4,000 worth of property and 10 people in 1917. The main office and branch warehouse were not moved from San Antonio to Kelly until June 1918. The depot supplied equipment primarily to Kelly, Brooks, Ellington and Gerstner Fields.

During the interbellum period of 1922-1939 the depots at Kelly and Duncan Fields were staffed primarily by civilians. By December 1941 when Pearl Harbor was attacked, the Duncan Field depot had 5,000 civilian employees and 1,275 enlisted men. Six months later, the depot had 21,000 civilian workers and over 5,000 enlisted men. At its wartime peak in 1945, the work force at Kelly Field had grown to 22,000 civilians--about 10,000 of whom were women--and some 6,000 officers and men.

Because it was more efficient to locate aircraft repair depots near the warehouses which supplied the needed parts, Aviation Repair Depot No. 1 at Dallas moved to San Antonio in March 1921 and consolidated with the Supply Depot at Kelly to form the San Antonio Air Intermediate Depot.

The four permanent buildings at Duncan Field in 1939 along with 13 temporary wooden shops and warehouses comprised 161,640 square feet of storage space. This became a part of Kelly Field when the two bases merged in March 1943. The nearby Normoyle Ordnance Depot was added to Kelly in February 1944. By the spring of 1945 the total area of Kelly Field comprised 2,833 acres. Its five concrete runways were 150 feet wide and together totalled 5.86 miles in length. In addition to the extensive shops for major engine and aircraft repair, Kelly had 18 hangars: one of concrete and asbestos (285 by 200 feet), seven of steel and concrete (160 by 122 feet to 264 by 200 feet), and 10 of wood (120 by 66 feet).

Kelly Field remained an air logistics center after World War II, filling the routine and the urgent supply and maintenance requirements of the Air Force, processing and storing aircraft and engines, and providing on-the-job-training in methods of aircraft mechanics, maintenance, and supply to personnel of the Air Force and of some Allied air forces.

Activities diminished at Kelly for a time after World War II and its personnel strength dropped to 12,000 civilian and 3,000 military workers. With the Soviet Union's blockade of West Berlin in 1948, however, came

Operation VITTLES, the Allied airlift of food, fuel, and supplies to the city, and a quickening demand for Kelly's services round the clock. From June 1948 to June 1949, Kelly's shops overhauled and shipped $50,000,000 worth of the engines which powered the C-54 aircraft in a continuous stream in and out of Tempelhof Air Base.

After VITTLES came the Korean War in June 1950. In order to expedite the removal of aircraft from storage and preparation for combat, Kelly established an outdoor production line and installed a special outdoor lighting system, dubbed "The Great White Way," to illuminate night operations.

Kelly's civilian work force doubled from 11,528 persons in June 1950 to 23,269 at the end of June 1952. Mechanization of the vast depot operation was being developed during this period, and continued even during Berlin Airlift and Korean War operations. Large overhead conveyor systems, a variety of automatic machinery, and IBM equipment for supply accounting were installed. These devices greatly facilitated the procurement, warehousing, and shipping of thousands of items which ranged in size and kind from instrument jewels to airfoil sections. Automated systems also were used in the complete overhaul of entire aircraft--including the re-treading of tires and the manufacture of plexiglass canopies--and aircraft engines, and in Kelly's worldwide logistic support responsibility for specific aircraft models and weapons systems.

Increasing demands were imposed upon the services of the San Antonio air logistics center in the early 1950's by the Korean conflict, making expansion of Kelly's physical plant a necessity. By mid-1955 Kelly's supply facilities, including the San Antonio Air Force Station (245.5 acres at Fort Sam Houston) annexed from the Army on July 1, 1955, comprised eight million square feet of warehouse space and seven million square feet of outside storage. Kelly's maintenance facilities comprised an additional three million square feet of shop space and used about 100 of the base's 1,172 buildings. Major construction projects completed by 1955 included the $16.5 million maintenance hangar and shops complex with one million square feet of floor space and a 250-foot open center section for accommodating the Air Force's largest aircraft. Kelly also boasted a new 11,550-foot runway, one of the longest in the Air Force, accommodating aircraft up to 200 tons; two new supply warehouses; and extensive engine-test facilities.

Kelly continued to grow after the mid-1950's. An air freight terminal was built and used extensively during the Southeast Asia conflict. An administrative building for Headquarters, USAF Security Service and a hangar and taxiways for a Texas Air National Guard unit were constructed.

Equipment, land (now 3,924 acres), buildings and runways, accounts receivable, and other assets at Kelly Air Force Base totalled nearly $1.8 billion by 1962. In Fiscal Year 1962, contracts awarded San Antonio

business firms amounted to $14.1 million, and in the calendar year 1962, Kelly--with an average military and civilian population of nearly 26,500--had an annual payroll of $136 million.

By 1967 too, Kelly Air Force Base, with its San Antonio air logistics center as a primary logistics support facility for the Air Force's efforts in Southeast Asia, had more than 30,000 military and civilian personnel who received an annual payroll of $225 million. More than 4,000 of the materiel management people worked in a 450,000-square-foot modern one-story office building converted in 1967 from a 24-year old warehouse.

The San Antonio area has been a center of air activities since the earliest days of aviation. Kelly Air Force Base witnessed this entire history and participated first hand in its dramatic evolution. The long, automated supply listings of often esoteric and complex aerospace systems and spare parts for which Kelly became responsible by the 1970's attested to the installation's continuing critical importance to the air defenses of the United States.

RICHARDS-GEBAUR AIR FORCE BASE, MISSOURI

Training of aircrews for World War II was still at a peak in early 1944, when the United States Government leased 559 acres at Grandview Airport, Missouri. The airport, located between the towns of Grandview and Belton, had been a group of small farms only three years earlier when officials of Kansas City had acquired 962 acres for an auxiliary airfield. But little was done to convert it to a serviceable flying field. The federal government wanted only a portion, for use as one of several satellite airfields of Sedalia Army Airfield, Missouri. The only government construction during the next year was a small control tower, a crash station, and runway improvement. Although some of the satellite airfields controlled by Sedalia Army Air Forces Base had military organizations assigned to them, no organization was assigned to Grandview Airport. Only a handful of civilian employees--primarily aircraft maintenance crews who serviced and repaired the C-46 troop carrier aircraft which occasionally used the field for emergency landings--were located there until November 1945, when even they were withdrawn. The government lease was finally cancelled in March 1946.

Renewed military interest in the airfield came on July 27, 1950, a month after the start of the Korean War. Lt. Gen. Ennis C. Whitehead, commanding the Continental Air Command, on that date recommended to

Headquarters, U.S. Air Force that a Central Air Defense Force be established to relieve the air defense workload of the existing Eastern and Western Air Defense Forces, and that the "home" for the proposed organization be either Kansas City, Missouri, or Oklahoma City, Oklahoma. By September, however, he had come to favor Grandview Airport as the best location. The Air Force granted approval for the new organization and the recommended site in January 1951. The General Services Administration began almost at once to arrange leases in downtown Kansas City, Missouri and at Fairfax Field, Kansas (across the Missouri River) to house administrative offices and personnel until construction at the new base could accomodate the organizations and people.

Central Air Defense Force was activated on March 1, 1951, in Kansas City. It soon selected Burns and McDonnell, a local architect-engineering firm, to prepare preliminary plans for the facilities to accommodate two headquarters, a fighter-interceptor wing, and base support organizations. Although General Whitehead recommended that the Air Force solely be responsible for base construction, USAF directed that the U.S. Army's Corps would be the construction agent.

Air Force funds were not available immediately to purchase the airport, so in May 1951 Kansas City officials were asked to donate the land. The officials were reluctant to do so at this time, and arrangements were

made to lease the airfield. A formal lease became effective on January 1, 1952. By this time, because of additional acquisitions by Kansas City, the airfield had grown to a total of 1,787.63 acres. The Corps of Engineers handled construction contracting, and work was supervised by the Kansas City District, Corps of Engineers. It awarded the first two contracts, one for a steel water tower and the other for a railroad spur, in April 1952. Construction began almost at once. For the remainder of 1952 and all of 1953, construction proceeded fairly continuously, interrupted for short periods by a few strikes and slow-downs by construction workers. During this two-year period of intensive effort, construction included runways, taxiways, aircraft parking and alert aprons; roads and parking areas; water, gas, electricity, sewage and central heating systems; a control tower; navigational aids facilities; aircraft wash racks and refueling hydrants; a base communications system; a railroad spur; water supply storage; open storage; bulk storage; a sewage treatment plant; a hangar with shops; an alert hangar; a parachute building; a receiver and transmitter building; a telephone building; a crash/fire station; a military police building; a crew readiness building; an administration and training building; a training aids building; an air installations administrative building; a general warehouse; a commissary warehouse; several barracks for airmen; a mess hall, three bachelor officers' quarters; a cold storage and meat cutting building; a service club; an officers' club; a photographic

laboratory; a chapel; motor transportation shops, storage, and office buildings; five family quarters; and two headquarters buildings. During this time the planned movement of the Continental Air Command to the base was cancelled, so construction of the large headquarters building that was to have housed it was cancelled. A planned hospital was also deleted, and medical facilities shifted to a portion of one of the three bachelor officers' quarters.

Grandview Airfield was officially renamed Grandview Air Force Base on October 1, 1952. Central Air Defense Force accepted accountability from the Kansas City District Engineer for all land, existing structures, and base facilities in January 1953. On July 29, 1953, a small detachment from nearby Fairfax Field moved into an old farm house still standing on the base, and the Corps of Engineers officially turned the base over to the Air Force. Headquarters, Central Air Defense Force and its various groups and squadrons began occupying completed structures at the new base during February and March, 1954. Once the military organizations in the area had moved to Grandview AFB, the Corps of Engineers terminated leases of facilities at Fairfax Field and in downtown Kansas City.

New facilities continued to be constructed at the base, including department and grocery stores, a cafeteria, a noncommissioned officers' club, a library, dining halls, and additional navigational aids. On December 22, 1954, Missouri's U.S. Senator, Stuart W. Symington, suggested

that Kansas City officials make a gift of the base's real property to the Air Force inorder that a permanent base might be established. City officials effected this generous civic action in May and June 1955. The deed was recorded officially on August 25 in both Jackson and Cass counties, Missouri, since the base was almost equally divided between the two counties. The deed gave title to the Air Force, but permitted Kansas City's use of the landing facilities "under emergency conditions."

As the nation's radar and early warning defense system began to grow, Grandview Air Force Base became a site for an Air Defense Command semi-automatic ground environment (SAGE) facility. Authorization was granted in 1955 for a hospital and 610 family housing units. Construction of the SAGE facility began in April 1956 and a contract was awarded that same month to the firm of Louis Henry Geis and George L. Dahl for the design of the family quarters. Additional land adjacent to the base was acquired later that year for the family quarters and also for extension of the North/South runway. Runway extension and repair work was carried out during 1957.

Action to select a new name for the base began late in 1955. On April 27, 1957, it officially was renamed Richards-Gebaur Air Force Base. Lieutenant John F. Richards, II, had died during combat in the first World War and Lieutenant Colonel Arthur W. Gebaur, Jr., had been killed over

North Korea in 1952. Both were from Kansas City.

Construction at the base continued on a rather large scale through 1960. The SAGE facility was completed and became an operational facility in the nation's air defense structure. All 610 of the new Capehart family housing units were occupied by 1960.

From its initial occupation in July 1953 until July 1, 1970, primary functions of the base centered around air defense.

Departure of the 71st Fighter-Interceptor Squadron in mid-1968 left the base without an air defense fighter squadron for the first time, and Air Defense Command use of the installation declined rapidly thereafter. However, other important flying units remained, including a troop carrier wing, a National Guard tactical reconnaissance wing, and a rescue and recovery wing.

Air Defense Command interest in Richards-Gebaur AFB began to wane, in mid-1967 and some thought was given to closing the base. Maintenance of base facilities, until then a matter of continued attention, was neglected. Instead of closing the base, however, the Air Force selected it as the new home for the Air Force Communications Service, one of the USAF's major commands. On July 1, 1970, that command assumed responsibility for the installation, and moved to Richards-Gebaur as its new owner and major tenant.

Movement of Headquarters, Air Force Communications Service to Richards-Gebaur brought dramatically increased expenditures for facility maintenance to correct deficiencies incurred during three years of partial neglect. A comprehensive survey of the installation in early 1972 revealed 2,079.24 acres of on-base real estate, acquired at a cost of $252,480.16, with easements covering an additional 339.05 acres at a cost of $111,071.03. Off-base real estate, used primarily for navigational aids facilities, added another 419.37 acres costing $80,141.00, and 288.79 additional acres covered by easement at a cost of $7,650.00. Base improvement costs by this time totalled $54,732,205.47. The base boasted 23 miles of paved roads, over 2,000,000 square feet of building space, 615 family housing units, a primary runway of 9,000 by 150 feet, a crosswind runway of 5,500 by 150 feet, and 384,180 square yards of concrete or asphalt aircraft parking apron.

Construction projects carried out during 1972 included an addition to the central heating plant, air conditioning of family housing and airmen dormitories, and major repairs to the airfield subdrainage and base sanitary sewage system, costing over $3.5 million. Fiscal year 1973 construction included several new structures, repairs, and modification and enlargement of existing structures, at a cost of $4.5 million. Programmed construction for fiscal years 1974-1976 includes 25 projects with an estimated cost of nearly $20 million.

Impact of Richards-Gebaur Air Force Base on the Kansas City area has been considerable. Most construction was accomplished by local firms. The considerable military and civilian payroll helped to enrich the local economy. In mid-1972 the base population included over 3,000 military and over 2,000 civilian employees. Military dependents added another 2,000 persons, and Air Force Reserve forces came to still another 1,500 persons. The Air Reservists, it should be noted, were civilian residents of the Kansas City area. Relations between the military installation and its surrounding communities had been cordial and cooperative. Annual open house events at the base were well attended by the civilian populace, and Air Force contributions to local charity drives always exceeded expectations. Kansas City welcomed the Air Force base on its southern boundary, and Air Force personnel became an important part of the community.

ALBROOK AIR FORCE BASE

Albrook Air Force Base was built on the Pacific side of the Isthmus of Panama as part of the Canal defense system and as an airfield to service nearby Balboa, site of the Panama Canal administration. Established while airpower was in its infancy, the base developed slowly except for a spurt of frantic growth during World War II. Almost from its inception, its growth was impeded by surrounding urban areas, the opposition of its neighbors, and natural obstacles. Flying operations were finally moved from Albrook to Howard Air Force Base in 1961, leaving only headquarters activities, housing, and certain support activities at Albrook Air Force Base.

Primarily a fighter base, Albrook Field also housed an air depot and supported a variety of special purpose aircraft from time to time. It was for many years the principal commercial airport for the Canal Zone, and by 1940 was the primary station there for Pan American Airways and lesser airlines. Like most of the older airfields, it began as a sod runway and progressed by stages to a modern airbase with paved runway and all of the modern facilities. Originally an emergency landing field, it was declared a military reservation in 1926, and on April 25, 1932 it was designated an active military airfield.

Few sites in the Panama Canal Zone were suitable in the 1920's for airfield construction. Numerous low hills were separated by swampy valleys containing sluggish streams and lakes. Just west of Panama City the Rio Maria Sala and the Rio Curundu emptied into what had been part of the estuary of the Rio Grande, forming a swampy area that was largely under water at high tide. A flood-control dike built around the mosquito-infested swamp in 1912 and 1913 provided a convenient dumping area for spoil dredged from the channel of the Panama Canal. The area was filled above the high water mark by 1915, and was reasonably level except for the scattered hills common to the region.

Need for an airfield on the Pacific side of the Isthmus led to selection of the filled area as the site for an emergency landing field. Because the reclaimed land was part of the Canal Zone, it cost the U.S. government nothing. A group of New York construction companies was given a contract in 1922 to put a dry fill on top of the hydraulic fill, remove small hills and obstructions from the area, and level the ground for aircraft use. The area adjoined the Canal Zone town of Balboa, so it was named the Balboa Fill Landing Field. A short turf runway, a temporary hangar, and fuel storage facilities completed the project.

France Field was the only Army Air Service base in the Canal Zone at the time. This facility, however, was located at the Atlantic end of the Canal where poor weather conditions frequently hampered flying activities.

In 1922 the Air Service established a small detachment, the 8th Air Park, at the new Balboa Fill Landing Field. The detachment commander and first base commander was Lt. Frank P. Albrook. He was killed in a crash at Chanute Field, Illinois, in July 1924, and the landing field at Balboa was renamed Albrook Field in his honor on November 11, 1924.

Construction of the flying field extended over many years and presented the engineers with formidable challenges. The original Balboa Fill Landing Field became a veritable lake after every heavy downpour of the tropical rainy season, and was thus fully operational during only four months of each year. During those four dry months, the aircraft stirred up so much dust that the residents of Balboa and other nearby communities protested loudly and persistently. The north-south alignment of the sod runway placed the southern approach and departure over the town of Balboa, while the northern end of the field terminated near several hills that forced steep glide slopes and climb angles. To further complicate the problem, the surface of the landing area continued to settle unevenly.

The Panama Canal Company in 1929 placed a hydraulic fill, varying from two to six feet in depth, over most of the airfield, and in 1931 an additional foot of dry fill was placed wherever there were to be buildings, parking ramps, or other construction. Drains and culverts were installed to draw off the surface water, hopefully within an hour or so after the rain stopped. Sink holes and soft spots had to be dug out and

refilled with coral or gravel, an almost endless process. A 1932 proposal for a paved runway caused consternation because more than a million dollars had already been spent on improving the airfield, apparently without success.

While the airfield surface was being improved, quarters and support buildings were also going up. The permanent hangars were duplicates of those being erected at air bases in the United States. Three-storied permanent barracks for the enlisted men were designed with the tropical climate in mind. Extra wide eaves kept out the tropical sun, high ceilings and thick masonry construction reduced the heat effects, and careful siting took advantage of existing breezes. Quarters for the families of officers and non-commissioned officers were erected in sufficient numbers to meet all requirements, and for a short time there was no housing shortage. Almost all construction was carried out under the control of the Army Corps of Engineers, with actual construction accomplished by the Panama Canal Company and civilian construction companies operating in the Canal Zone. The troops themselves did much of the manual labor, particularly the tasks of beautifying the base and making it livable.

Drains were exposed as dangerous mounds and additional soft areas appeared where aircraft foundered even during the dry season as the flying field surface sank another foot or more by 1932. Constant repair of the landing area was consuming large sums of money annually, but each repair

made the landing surface more uneven. A paved runway was finally approved in 1936, begun in 1938, and finished in 1939. The six-inch reinforced concrete surface, poured atop a clay subgrade over hydraulic and dry fill, was 4,700 feet long and 250 feet wide, adequate for all aircraft then in use.

Most construction on the base in the late 1930's involved headquarters and technical buildings, including a new telephone exchange. Temporary quarters were added to the older permanent housing, but the influx of personnel caused an acute shortage of family housing that was to last for years. A large growth in the numbers of military and civilian personnel early in World War II further aggravated the problem, even though additional temporary housing was authorized and built.

Plans were made to move the Panama Air Depot which had originated at France Field, to Albrook Field. A construction project provided the necessary hangars, shops, and warehouses adjacent to the airfield, and the depot gradually moved. Initially it was manned by civilians and military personnel in about equal numbers, but it was intended that the manning would ultimately be all civilian. The Depot soon became the most extensive single building area on the base.

Increased numbers of arrivals and departures by larger military aircraft and commercial airlines during the late 1930's caused the runway to crack and deteriorate, while the airfield surface continued its inexorable

uneven settling. Major asphaltic overlays on the runway to repair the damage cost an average of $200,000 annually. In the process of repair, the runway was extended to 6,850 feet, its absolute maximum. An effort to build a costly commercial airline terminal building was defeated, and a commercial airfield was eventually built at Tocumen, northeast of Panama City. Although repair and maintenance of Albrook Field continued, there were no additional major construction projects.

Albrook's climate was characterized by heat and high humidity. In 1960, the Air Force designated Albrook a tropical base, and authorized air conditioning for some of the base buildings, beginning with the Service Center, base headquarters, and command headquarters buildings. Air conditioning of living quarters, however, did not begin until 1972. Street lighting was installed in 1973. Despite a decrease in Air Force presence and a continuing effort to provide more quarters, the housing shortage became so critical by 1973 that many military families were prohibited from accompanying their service men husbands to Albrook AFB until the situation improved.

Relations between Albrook Field and the nearby communities of Balboa and Panama City were strained from the very beginning. Because the runway alignment was north-south, aircraft departing to or landing from the south were forced to fly low over the town of Balboa, aggravating residents already upset over the noise and dust. Despite the obvious danger, buildings

continued to be erected in line with and close to the runway end, forcing pilots to exercise the utmost skill and caution. By 1940, aircraft approaching or departing over Balboa flew low over the Community Center, a housing area, the Balboa schools, a church, and the Panama Canal Administration Building. Heavily loaded aircraft regularly cleared the roof of the school buildings by no more than 50 feet during takeoff, the most critical time for an engine failure.

A second runway with a different alignment was proposed. Before further action could be taken, additional construction filled the proposed approaches with buildings. The second runway was never built. Officials considered removing the schools and other buildings from the approach zone of the existing runway, a less expensive solution than relocating the entire air base. But there was too much public opposition. A high bridge built across the Panama Canal in 1960 was situated in the approach zone, creating yet another safety hazard and one more impetus for closing the base. Aircraft movements were limited during the hours of darkness and while church services were being conducted on Sunday. The residents of Balboa and Panama City, however, remained dissatisfied.

The agitation to close the base began in earnest in 1946 and rose to a crescendo in 1949, aided by a highly vocal press. The Governor of the Canal Zone proposed officially but unsuccessfully that the Air Force move

to Howard Air Force Base on the other side of the Canal and turn the Albrook base over to the Zone. Tensions relaxed for a while thereafter, but the pressure was renewed in 1955. Most Air Force flying activity was moved to Howard Air Force Base in 1961. Other Air Force activities were being similarly shifted, suggesting the possibility that Albrook Air Force Base might one day be relinquished entirely by the Air Force. The Albrook runway was still used by U.S. Army helicopters and light aircraft, however, and the U.S. Air Forces Southern Command continued to maintain its headquarters on the base.

Albrook Air Force Base was a vital factor in the political, economic, and military development of Central and South America. Its air rescue and base units saved hundreds of lives over the years, primarily through civic actions that airlifted patients to hospitals and took essential supplies to the scene of accidents and natural disasters. Over 13,800 pounds of supplies were airlifted to Guatemala in June 1973 to aid those displaced by heavy flooding. In response to the disastrous earthquake of December 23, 1973, Albrook dispatched relief teams, engineers, doctors, and supplies to Managua, Nicaragua, and kept the relief operation going for more than a month.

The Inter-American Air Force Academy at Albrook Air Force Base was a unique organization with an immeasurable impact upon every nation in

Central and South America. Air Force personnel from many countries came to Albrook Air Force Base for training in a wide spectrum of subjects and skills, thereby raising the technical proficiency level of their countries. Of even greater importance, the students worked with military personnel of other nations, hopefully establishing friendships and understanding that might overcome ancient hostility and bring the peoples closer to each other. Although it was criticized occasionally by agitators of various persuasions, the Academy was generally conceded to have contributed substantially to increased understanding in Latin America.

Local Panamanians working at Albrook Air Force Base increased their skills while maintaining gainful employment. American military personnel spent heavily in Panama for essential commodities and recreation. Many local products were sold to the base and its personnel. The Canal Zone as a whole was a major boost to Panama's economic and social growth, and Albrook Air Force Base was an integral part of this development.

THE UNITED STATES AIR FORCE ACADEMY

Establishment of an Air Force Academy was a natural outgrowth of the evolution of American military aviation. The vital role of air power in World War II triggered Congressional proposals for establishing an air academy, but these were dropped upon the conclusion of the war. The plan was revived with the birth of the independent Air Force in September 1947 and the increasingly dominant part played by United States air power in the nation's defenses. On August 9, 1948 General Muir S. Fairchild, Vice Chief of Staff, conferred with senior Air Force officers and prominent educators about a planned air academy. The following March, Secretary of Defense James Forrestal appointed a Service Academy Board. An Academy Site Selection Board, headed by retired General Carl Spaatz, was then appointed, and made preliminary studies of several hundred suggested sites. In December 1948, Lieutenant General Hubert R. Harmon was named Special Assistant to the Chief of Staff for Air Force Academy Matters and charged with all planning for the future Air Force Academy.

The Korean War again delayed the establishment of the Academy. In January 1954, Congress began hearings on a Defense Department-sponsored proposal for establishment of the Air Force Academy. Both Houses of Congress passed a bill on March 29, 1954. The President signed it into law three days later. The Secretary of the Air Force Harold E. Talbott thereupon

appointed a Site Selection Commission, and the Department of Defense announced the main selection criteria: a minimum of 15,000 acres, scenic beauty, various community aspects, utilities, transportation, flight training facilities, a daily water supply of 3,000,000 gallons, and climate favorable to flying.

Eventually, of the 580 site proposals made to the Site Selection Committee, three were recommended: Alton, Illinois; Lake Geneva, Wisconsin; and a site eight miles north-northwest of Colorado Springs, Colorado. Secretary Talbott announced the Colorado site as the Academy's future home on June 22. He designated Lowry Air Force Base, Denver, Colorado, 60 miles away, as the interim site pending completion of construction. On July 27, 1954, the United States Air Force Academy was established under the Chief of Staff of the Air Force. It was activated on August 14 as a separate operating agency, with General Harmon assuming the post of Commandant. The Academy was officially dedicated at Lowry on July 11, 1955 and the first class of 306 cadets recited their oaths of office.

Congressional dissatisfaction with some of the permanent site designs caused a year's postponement of the move to Colorado Springs, originally planned for fall of 1957. The second and third cadet classes were limited to about 300 cadets each, because of the severe space restrictions at the interim location at Lowry. In early September 1958, faculty and cadets left for the new Academy which was then 86 percent complete.

Authorized strength of 2,500 cadets in the Cadet Wing was reached in 1962. Two years later Congress passed a bill authorizing an annual increase in the size of new cadet classes, up to a maximum of 4,442 cadets in 1972. This legislation was intended to equalize student strength at the Air Force, Army and Naval academies.

Situated on 18,128 acres of former ranch lands, the Academy is further protected from commercial activity by an additional 145-acre easement, which provides room for future Academy expansion. The site lies in a beautiful setting--a series of five finger-like mesas separated by picturesque valleys. It is backed to the west by the Rampart Range of the Rocky Mountains and overlooks the plains and the Black Forest to the east. The Academy lies between the plains and the mountains in a semiarid zone of variable vegitation. The climate demands a comprehensive water conservation effort. Maintenance and beautification of the Academy grounds are a major responsibility of the Base Civil Engineer. In 1965 an Academy Forestry Program was launched to which was added, in 1969, an Academy Conservation and Beautification Program.

Construction at the permanent Academy site constituted one of the great community building projects in the nation's history. The Air Force Academy Construction Agency, an activity of Headquarters, USAF, was responsible for the construction of the original facilities in 1954. At that time there was no major defense construction activity in the Colorado Springs area. Consequently, the Air Force acted as its own construction agent.

Academy engineers, under the Academy's Deputy Chief of Staff, Civil Engineering, had to depend on their own resources for work customarily contracted to commercial architect-engineers. Some variation in planning concepts in the initial stages of design confounded the engineering task. By 1964, the Corps of Engineers was active in construction at nearby Peterson Field, at the Army's Fort Carson, and at the continental defense post being built within Cheyenne Mountain. When these projects phased out, the Corps of Engineers assumed construction responsibility for the new Academy expansion program. The Air Force Regional Civil Engineer Authority monitored the program until June 1, 1966, when the Academy's Deputy Chief of Staff, Civil Engineering took over. Also in 1966 the Aerospace Defense Command and the City of Colorado Springs formally agreed to permit the Air Force to use the runways and aviation facilities at Peterson Field until the year 2066.

Design of the first increment of enlarged cadet quarters and of related support facilities was completed in October 1965. The construction project was completed ahead of schedule in December 1967. Fairchild Hall, the academic building, was enlarged during June 1966-October 1968. Because release of FY 1967 construction funds was delayed, the contract for the subsequent increment of the cadet quarters was not awarded until May 1967. Building was completed in March 1969. The dental clinic was expanded in 1968 and again in 1972. Renovation of the cadet dispensary was completed in

May 1968. In November 1969 a large (29,000 square foot) addition to the Academy Hospital was completed.

During 1965-1970, the 56,000 square foot aeronautics laboratory grew into a modern, well-equipped scientific facility. It included a smoke tunnel, ten subsonic, five supersonic and a trisonic wind tunnel, heat transfer and thermodynamics experimentation facilities, several shock tubes, and engine test cells. A $7.9 million cadet gymnasium and a $7 million Athletic Field House were also constructed during this period. Expenditures for contracts let during 1965-1970 within the Academy expansion program were estimated at $38,000,000.

After 1970, a new electronics lab was completed. The Academy continued to expand. Plans in the early 70's included a new non-commissioned officers club, airfield and airfield facilities improvements, and 200 additional family housing units for faculty and staff members. Because bids submitted for these quarters considerably exceeded the programmed budget, the Academy was directed in July 1973 to hold the housing project in temporary abeyance.

Construction projects in FY 1973 approximated $2 million. They encompassed base facilities, housing, hospital and nonappropriated funds activities, a fuel tank, an addition to the Auto Hobby Shop and a multipurpose craft shop. For example, construction of the Flight Indoctrination Facilities at the Academy Airstrip was a major project during 1972/1973. The Penner Construction Company of Lakewood, Colorado was competitively selected as the prime contractor in February 1973 for the $1,871,046 project.

Main structures and facilities, most of which were named for famous Air Force leaders, included:

Vandenberg Hall, a cadet dormitory with 1320 rooms, later expanded to include new cadet dormitory with 830 rooms;

Fairchild Hall, the cadet academic building, with nearby aeronautics and radio frequency systems laboratories;

Mitchell Hall, the cadet dining hall;

Arnold Hall, the cadet social center;

Harmon Hall, the administration building;

the Academy Planetarium;

the cadet Gymnasium and Field House;

the cadet Chapel.

The Academy also maintained Farish Memorial, a recreation area of 655 acres, the original 60 acres of which were donated by the Farish family in 1959.

Architectural style of the Academy buildings was contemporary and resembled that of many new commercial buildings. The style was accentuated by liberal use of white marble and masonry, steel, aluminum, and glass. The design of all new facilities remained faithful to the original architectural concepts.

There were over 100 miles of Academy roads, 75 miles of which were paved. The Academy was divided into three major areas to separate the cadet, support and family facilities.

A distinctive feature of the Air Force Academy is its dual role as a functioning military organization and as an educational institution. As a separate operating agency under the direct control of the Chief of Staff, USAF, it was roughly equivalent to a major air command such as Strategic Air Command or the Air Training Command. The Academy was also an Air Force base with responsibility for many of the flying facilities and operating elements normally associated with active air bases.

The Academy's mission was to develop broadly educated professional military officers. It provided cadets with a source of the academic knowledge essential to modern Air Force officers. A broad military education served as a foundation for their career development. Leadership, technical and physical training opportunities helped to develop individual capabilities and skills. The Academy also sought to develop in each cadet the traditional ideals of duty, honor and service to his country.

Public-spirited citizens, realizing when the Academy was established in 1954 that an effective alumni group would not exist for a number of years, organized the Air Force Academy Foundation, Incorporated. Through the years the Foundation's membership expanded to include nationally prominent citizens. As a private, nonprofit Academy-affiliated agency, it supported

the Academy with facilities not provided from government funds. It sponsored the establishment of such major facilities as the 18-hole Eisenhower Golf Course, the Farish Memorial Cadet Recreation Area in the nearby Rampart Range Mountains, and the 40,000-seat Falcon football stadium. A planned Aerospace Education Center would provide a place where military and civilian citizens could meet, exchange ideas, and promote mutual understanding.

The Academy planetarium was one of the major planetaria in the United States. It presented educational programs to schools and to the general public, and was especially popular with local area elementary and high schools. Planetarium staff members acted as the Academy collection agency for Apollo material and answered public inquiries about the lunar program. It also supported NASA directly by teaching astronauts the use of the manual space sextant and stadimeter for Skylab experiments. The planitarium staff also conducted programs for handicapped and retarded children.

Close rapport with the public was maintained by the Academy Library through tours for local schools, colleges and civic organizations. In addition, the library responded to an increasing number of requests from students pursuing graduate studies at neighboring universities and from local industry-affiliated researchers.

Academy educators participated in a wide variety of activities within the U.S. academic community. For example, the Department of Electrical

Engineering recently hosted a tri-service radar symposium and a NATO electronics symposium. Historians congregated at the Academy biannually for a symposium on military history.

As a public works facility the Air Force Academy was perhaps best visible in its role in youth and welfare activities. The Academy's Current Plant Division coordinated plans for utilizing Academy resources in support of the many youth activities that involve Academy facilities and personnel. There was a continuous stream of activities such as AFROTC, summer encampments, Civitan Youth Seminar, National Model Rocket Championships, Armed Forces Day and Parents' Weekend. Each summer, the Academy hosted a Summer Youth Program for underprivileged teenagers from the Denver area. Disadvantaged local youth were employed at the Academy as part of the Federal Summer Employment Program. At the annual "Operation Easter" several hundred youngsters from all parts of Colorado enjoyed a day of fun and games at the Academy. Academy cadets also staged an annual "Operation Christmas" for children and families in the Pikes Peak region. Under this program some 500 cadets hosted about 800 children at parties on the Academy grounds, in Colorado Springs, Denver and Larkspur, and purchased food baskets for needy families. The cadet-organized "Interaction Club" donated money to the Colorado Springs Salvation Army, bought food baskets for needy local families, visited schools and welfare agencies during the Christmas holidays, and on occasion provided cadets as substitute teachers in local schools.

During FY 1971, 250 cadets, in a Christmas "Grassroots Program," made wide public appearances designed to promote interest in the Academy. Cadets spoke on radio and television, and to civic and professional clubs. Black cadets in this program furthered the Academy Equal Opportunity Program by speaking to interested high school students.

Striking architectural and natural beauty of Academy facilities made the Academy one of Colorado's top tourist areas, attracting well over a million visitors each year. The Academy Base Civil Engineers built two nature trails for public use. Escorted Academy tours were available for special groups from all sections of the U.S. Of the 750,000 visitors who came between July and Labor Day in 1970, 120,000 visited 304 presentations at the Academy planetarium. The Academy Band presented outdoor concerts each Sunday evening during the height of the tourist season. The Band and the Academy Drum and Bugle Corps also gave many performances at public and community affairs, and played in the 30-minute weekly radio show "From the Ramparts," aired nationally by approximately 100 radio stations.

Natural gas supplies did not keep up with the rapid population growth of the Colorado Springs area. Studies by the Colorado Springs municipal authorities and by Colorado Interstate Gas (the supplier) forecast that the natural gas shortage would continue into 1976. During FY 1973 an interrupted natural gas service to the Academy created an additional budgetary requirement of $577,000 for fuel oil.

Complaints of "noise pollution" were made in 1970 by a group of residents from nearby Woodmen Valley. The issue centered around the use of the U-10 tow aircraft. The U-10 was subsequently replaced by the quieter Super Cub.

Zoning problems also arose as urban Colorado Springs continued to expand toward the Academy. During 1972/1973 Academy authorities protested that the proposed developments at Chapel Hills, east of the Academy, violated former agreements. Writing to the El Paso County planning director, the Academy Chief of Staff observed that as developers of Chapel Hills amended their plans, population and building density in the area had increased, presenting potential safety hazards for Academy flying activities. The Academy was also working with the Colorado Ground Water Commission to control the mining of water resources in the Academy area until the availability of continuing water supplies to the region is established.

Being primarily an institution of higher learning, the Academy has not been entirely immune to the protest activities of off-base dissidents during recent periods of public unrest. A bomb exploded on July 31, 1972 in a trash-box outside the Academy Officer's Club. Antiwar activity was particularly virulent during July-Dec 1972 but declined upon the cessation of hostilities in Viet Nam. Coordination and liaison between all agencies participating in dealings with antiwar demonstrators during this period was exemplary.

Academy Hospital provided medical services for over 4,000 cadets and more than 9,000 military personnel and their dependents. In addition, it treated active and retired members of all uniformed services in the Colorado Springs area. The Academy hospital was available to an estimated 19,000 eligible retired personnel and their dependents living in the popular Colorado Springs area.

Many national awards for public service have been made to the Academy. On October 28, 1969 it became the first service academy to receive the National Safety Council's "Award of Honor"--the highest recognition conferred by that body for safety programs in colleges and high schools. The Honorable Phillip Whittacre presented the Academy the runner-up award for the Defense Department's Natural Resources Conservation Award on October 29, 1970.

FRANCIS E. WARREN AIR FORCE BASE

Earliest roots of Francis E. Warren Air Force Base, Wyoming lie in the building of the railroad across the desolate Western frontier in the 1860's. President Lincoln issued authorization in 1862 to establish a fort in the Wyoming territory to provide protection for Union Pacific Railroad construction workers. Elements of the frontier Army deployed to an early settlement located at the point where the railroad was to cross Crow Creek. General G. M. Dodge named the location Cheyenne. As the railroad pushed forward from Julesburg, Colorado, toward the Crow Creek crossing, three Army infantry companies under Colonel J. D. Stevenson's command moved from their Larrens River encampment to the crossing. They arrived on July 21, 1867 and prepared an interim camp about a half mile west of the Cheyenne settlement. Within a month they were joined by additional troops, and the entire camp moved about two and a half miles further west. They began construction of a permanent military post at this site.

Log barracks, huts and a hospital were among the first buildings erected at the "Post on Crow Creek." This cantonment, which never had the customary stockade walls, was officially designated Fort David A. Russell, honoring a Union Brigadier General killed during the Civil War. The post was commonly referred to as Fort D. A. Russell.

Captain Elias B. Carling of the Army Quartermaster Corps, within the month after the arrival of the first troops, began construction of what became the United States Army's second largest quartermaster supply depot and one of the most elaborate posts in the American West. Wooden structures were replaced by permanent brick buildings over the next 18 years.

The supply section of the military post was called Camp Carling. As Army operations against the Plains Indians lessened, Camp Carling lost much of its usefulness. In 1860 some 16 warehouses, vegetable storage cellars, stables, corrals and living quarters at Camp Carling were declared surplus. Residents of nearby Cheyenne bought most, but a few buildings were kept by Fort Russell. With the turn of the century the Fort again began to expand. By 1917 it had acquired a 90-square-mile target and maneuver range, built cavalry barracks, family quarters and a rifle range, and laid underground telephone cables. In 1919 Fort Russell became a post-World War I demobilization center. Six years later Fort Russell ceded its target and maneuver range to the Pole Mountain District, Medicine Bow National Forest. From 1925 until 1930 Fort D. A. Russell was home for the 1st and 20th Infantry; summer encampment locale for the Officers Reserve Corps, Reserve Officers Training Corps and a Citizens' Military Training Camp; and a site of a radio station operated by the Department of Commerce.

Of the many military men stationed at Fort Russell, perhaps the most famous was General John Joseph Pershing. Pershing married the daughter of Francis E. Warren after whom the Fort was renamed in 1930.

Francis Emroy Warren enlisted in a Massachusetts regiment during the Civil War. He was awarded the Medal of Honor for action near Port Hudson, Louisiana. En route west after the Civil War, he served as a construction foreman on the building of the Rock Island Railroad west of Des Moines, Iowa. After pursuing a business career in agriculture and real estate in the Cheyenne area, he was appointed the Wyoming Territorial Governor. Later he became the new state's first elected governor. Still later, Wyoming citizens elected him their U.S. Senator.

Throughout the West, adequte water supply was critical to the survival of railroads, cattle barons, towns and the defending military units. The Army and the Union Pacific Railroad together decided in 1868 to bring the waters of Pole and Crow Creeks to Cheyenne by means of a canal through the military reservation. The Union Pacific surveyed and engineered the line of the canal. Military troops then constructed the canal as far as the reservation boundry, from where the water supply could be diverted to any part of Cheyenne. Fort Russell of course shared the use of the water. There was occasional disagreement between the Army and the citizens of Cheyenne over water rights. However, joint water usage generally worked out well. Between 1870 and 1931 the Army and the city

dug ditches, laid pipes and built reservoirs. In 1931 specific tracts on the Crow Creek watershed and lands adjacent to the Granite Springs, Crystal Lake and North Crow Reservoirs were transferred to the War Department to protect Fort Francis E. Warren's water rights.

Until the end of the Second World War the Army used Fort Warren primarily for training. Almost 400 temporary structures were built in the early 1940's to house 30,000 troops. In 1942 the Army began a Quartermaster Officer Candidate School. The Women's Auxiliary Army Corps arrived a year later. Until 1946 the Army maintained a prisoner of war camp at the post.

Declared excess to Army needs in 1947, the post came under control of the Air Force's newly formed Air Training Command. That organization used it to train civil engineers. In 1949, it was officially renamed Francis E. Warren Air Force Base. It remained a "non-flying" component of the system of installations supporting the Air Training Command for nearly a decade thereafter.

Fundamental in the initial stage of ballistic missile development in the mid-1950's was the selection of large installations to accommodate a system of launch sites, silos, guidance apparatus, access roads and supportive facilities. The Air Force's Ballistic Missile Division initiated a nationwide site survey. Planners identified Warren Air Force Base as a

potential location in October 1956. It was named in May 1957 as the future home of the 706th Strategic Missile Wing. Control of the base then passed from the Air Training Command to the Strategic Air Command. From a historic cavalry outpose during the 1860's, Warren Air Force Base became an integral part of the missile age. Several factors influenced the choice of Warren. First, as an active base under the operational control of Air Training Command, it had facilities that were still usable, although requiring many modifications to support the unique space mission. Secondly, Warren and its environs provided large tracts of empty and available land ideally suited for the construction of missile launching sites and complex interconnecting arteries. Finally, the Warren location could physically expand should the need arise.

The Wyoming State Tribune of September 26, 1957 reported to an enthusiastic populace that land surrounding the city of Cheyenne was being considered for a secret project, and the U.S. government was negotiating the purchase of 8905 acres. The press later reported that full and fair compensation would be made to the eight private landowners involved. Additional information finally was released identifying the installation as an Atlas missile base comprising four separate launch complexes at various distances around Cheyenne.

Wyoming's Senator Frank A. Barrett asserted on October 15, 1957 that the defense project near Cheyenne would "prove to be the biggest thing that has happened to the city since the coming of the railroad. . . It will be one of the largest military establishments in the country. I can give no estimate of the cost, but that cost will be fantastic."

Sealed bids on construction contracts for the first site, northwest of Cheyenne, were opened on July 8, 1958. Construction began the following November. The Corps of Engineers was not yet permitted to disclose cost figures. But it did release to the public the site's specifications. The design included six reinforced concrete launch and service buildings, each measuring 133 by 104 feet; two two-storied operation buildings or "blockhouses," 73 by 78 feet, also made of reinforced concrete; and 7- by 18-foot access tunnels. Concrete retaining walls seven to ten feet high and 100 feet long flanked each building. Construction at this first site required 291 cubic yards of excavation, five miles of seven-foot chain link fence, five thousand feet of culverts, 4 1/2 miles of 6- to 18-inch water lines, seven thousand feet of 6- to 8-inch sewer lines, 6 1/2 miles of underground electric duct banks and miles of paving.

Acute and difficult problems arose as construction got underway. Vehement objections came from an organized group of pacifists which attempted to mobilize public pressure to stop construction. Short of stoppage, the

protesters were determined to cause as many delays as possible. Patient and persevering public relations efforts of Air Force and community leaders finally prevailed and obstructionist tactics declined. Strikes by contractor personnel presented a more ominous threat. Although such occurrences were a legitimate part of a free enterprise system, these incidents were particularly severe, as they directly affected the defense posture of the nation. In spite of hard bargaining, the project at Warren Air Force Base experienced 31 costly strikes over a three-year period. These strikes caused a loss of 23,664 man-days of work. So critical were resulting delays that Congress convened a hearing to investigate the circumstances.

Local citizens recognized that defense expenditures in the State of Wyoming would revitalize the economy of the state and would directly impact the economy of Cheyenne. The community was enthused and elated over the Atlas construction project. Press reports estimated the costs for the entire project at 100 million dollars. The anticipated influx of military personnel and construction workers, and their families, spelled a virtual "boom" for Cheyenne and its business community.

Cheyenne's Chamber of Commerce in February, 1958 asked an industrial consultant to estimate the economic and social impact of the missile project. The consultant advised that Cheyenne should prepare itself for an additional influx of 20,000 people and that the community would need at least three

times the number of teachers, service trades, and new houses. Trailer units increased by 2500 within a matter of months. For the first time since 1935 the issuance of building permits for new housing starts began to climb steadily. Employment opportunities in and around Cheyenne, heretofore lower than the national average, began a marked increase. New highways and access roads were built and school plants expanded to accommodate hundreds of new students. For the 32,000 residents in 1958, the catalytic Atlas program marked the beginning of unprecedented community growth.

Prior to Defense Secretary McNamara's 1964 decision to phase out Atlas missiles, the Air Staff studied potential uses of inactive missile facilities. The launch sites at Warren Air Force Base were among those involved in the planned deactivation. The Air Force determined in 1965 that because of the remote locations and single-purpose construction of Warren's Atlas facilities, they were not suited to further usage by the Air Force. Non-military uses were explored. The USAF, prior to relinquishing jurisdiction, removed missiles, spare parts and certain salvageable equipment such as diesel generators and air conditioners for storage, disposal or reuse elsewhere. The General Services Administration by 1966 had made one site available to a local engineering firm for gas flow research; one to the National Science Foundation for atmospheric research; one became a research facility for Colorado State University; and one was used by the county Civil Defense organization.

For the second time in a decade Warren Air Force Base underwent extensive construction, as the advanced Minuteman intercontinental ballistic missile system replaced the Atlas. Within a 100-mile radius of Warren arose 20 launch control centers and 200 silo launch facilities covering 8300 square miles of Wyoming, Nebraska and Colorado. Excavation required moving 2.7 million cubic yards of earth and rock. Building materials included ten thousand railroad cars of concrete and enough steel to make sixty thousand automobiles. Electronics engineers installed 2240 miles of communication cables in trenches four feet deep. When construction was completed, the Air Force's Ballistic Systems Division passed operational control of Warren's Minuteman defenses to the Strategic Air Command.

A 600-acre area of Francis E. Warren Air Force Base was designated a National Historic Site under the National Historic Preservation Act in October 1969. Preserved on this site were 124 buildings and facilities identified by the Wyoming State Archives and Historical Department as having significant historical value.

Cheyenne's city government in May 1970 asked Air Force approval to annex Francis E. Warren Air Force Base. Headquarters, USAF determined shortly thereafter that the proposed annexation would not be in the best interests of the Air Force at that time. The annexation request, however, was an indication of the close interrelationship that existed between the city and the installation.

Francis E. Warren Air Force Base, in going from "muskets to missiles," compiled the longest continuous history of federal service of any U.S. air installation. Recently Ned Frost of the National Registry of Historic Places remarked, "Wyoming has no other single historic focus point, no other single historic heritage, more representative of its past, its present and its indicated future, than F. E. Warren Air Force Base."

BIBLIOGRAPHY

The sources of this history include official documents and unit histories located at The Albert F. Simpson Historical Research Center, Air University, Maxwell AFB, Alabama.

Acker, William James. The Impact of Military Employment on Adjacent Urban Areas: A Case Study of the United States Air Force Academy and Colorado Springs. Ph.D. dissertation, Syracuse University, 1969.

Buss, Lydus H. Seaward Extension of Radar 1946-1966. Continental Air Defense Command Historical Study No. 10, c.1956.

Chronology of Significant Aerospace Events. Washington, D.C.: GPO, 1972.

Craven, Wesley F. and James L. Cate (eds.). The Army Air Forces in World War II. Chicago: University of Chicago Press.

A seven volume history, fully documented, of all aspects of the U.S.A.A.F. in World War II.

Crowell, Benedict. America's Munitions 1917-1918. Washington, D.C.: GPO, 1919.

DeLonge, Merrill E. Modern Airfield Planning and Concealment. N.Y.: Pitman Publ. Co., 1943.

Incorporates airport planning, both military and civilian, with wartime requirements for concealment, camouflage and flying safety. Written during World War II by an Army Air Corps officer.

Fairchild, Byron and Jonathan Grossman. The War Department: The Army and Industrial Manpower. U.S. Army; Office of the Chief of Military History. Washington, D.C.: GPO, 1959.

Froesch, Charles and Walther Prokosch. Airport Planning. N.Y.: John Wiley & Sons, 1946.

Futrell, Robert F. "Background and Growth of Military Civic Actions: Recent Military Civic Action in the United States Air Force." Unpublished paper. Albert F. Simpson Historical Research Center, Maxwell AFB, AL.

Futrell, Robert F. "Background and Growth of Military Civic Actions: The Role of Military Civic Action in the Development of the United States." Unpublished paper. Albert F. Simpson Historical Research Center, Maxwell AFB, AL.

Futrell, Robert F. Development of AAF Base Facilities in the United States, 1939-1945. Unpublished historical Study. Albert F. Simpson Historical Research Center, Maxwell AFB, AL.

Futrell, Robert F. The United States Air Force in Korea 1950-1953. N.Y.: Duell, Sloan and Pearce, 1961.

The official, documented history of USAF operations during the Korean War.

Goldberg, Alfred (ed.) et al. A History of the United States Air Force 1907-1957. Princeton, N.J.: D. Van Nostrand Co., 1957.

Hanks, Stedman Shumway. Aviation Gets Down to Earth: The Growing Need For Public Landing Fields. Boston: Aviation Information Service, 1940.

Discusses expanding aviation and need for ground facilities, including military bases and civilian schools to train military flyers, on the eve of the pre-World War II growth.

History of ATC in Greenland, July 1941-August 1945. Unpublished Air Training Command historical study. Albert F. Simpson Historical Research Center, Maxwell AFB, AL.

Holley, Irving B., Jr. Ideas and Weapons. Washington, D.C.: Industrial College of the Armed Forces, 1947.

Huzar, Elias. The Purse and the Sword: Control of the Army By Congress Through Military Appropriations, 1933-1950. Ithaca, N.Y.: Cornell University Press, 1950.

Lang, James D. Construction and Maintenance of Airfields in the Far North Regions. Technical Assistant to Chief of Naval Operations for Polar Projects, 1956.

Considers unique problems of locating and constructing airfields in arctic regions.

Langer, William and S. Everett Gleason, The Challenge to Isolation: The World Crisis of 1937-1940 and American Foreign Policy. N.Y.: Harper and Row, 1964 (1952).

Langer, William and S. Everett Gleason, The Undeclared War 1940-1941. N.Y.: Published for the Council on Foreign Relations by Harper, 1953.

Lewis-Dale, Henry Angley. Aviation and the Aerodrome. Philidelphia: J. B. Lippincott, 1932.

Early treatment of the problems of a rapidly advancing aviation system, especially in England, as they related to airport site selection, design and construction.

Metcalf & Eddy and LaPierre, Litchfield & Partners. Greenland Completion Report 1951-1955. N.Y.: U.S. Army Engineer District, Eastern Ocean Corps of Engineers (undtd).

An account of construction activities and an analysis of the development of arctic engineering design for this period at three U.S. air bases in Greenland - Thule, Sonderstrom and Narsarssuak - with biblio.

Morenus, Richard. DEW Line. N.Y.: Rand McNally, 1957.

The story of the beginnings, construction and extension of the DEW Line, 1945-1957.

Piepenburg, Dwayne D. Interim Report on the Evaluation of a Steel Arch Protective Shelter. (1597-01) USAF Weapons Laboratory, 1966.

An example of the work done in staged construction of protective shelters for modern military aircraft employed in combat zones.

Proceedings: Conference on Ground Facilities for Air Transportation, September 12 to 14, 1950. Cambridge, Mass; MIT, 1950.

Report on the Second Stage Reconnaissance for the DEW Line. 2 Vols. N.Y.: Seelye Stevenson Value and Knecht, August 1955 (vol. 1), January 1956 (vol. 2).

Recommendations regarding site selection and construction of the radar stations comprising the DEW system.

Ross, B.M. (ed.). Materials and Methods for Military Airport Construction. Aurora, Ill.: Barber-Greene Co., 1942.

Reflects the technical and engineering experience of a construction firm engaged in building airbases. Intended for the use of combat engineers in World War II.

Rutkowski, Edwin H. The Politics of Military Aviation Procurement, 1926-1934: A Study in the Political Assertion of Consensual Values. Columbus, Ohio: Ohio State University Press, 1966.

Ties the defense procurement process of the period to concepts of policy-making.

Sweetser, Arthur. The American Air Service. N.Y.: D. Appleton and Co., 1919.

The Civil Engineer in War: A Symposium of Papers on War-Time Engineering Problems, Vol I: Airfields, Roads, Railways and Bridges. London: Institute of Civil Engineers, 1948.

The Official Guide To the Army Air Forces AAF: A Directory, Almanac and Chronicle of Achievement. N.Y.: Simon and Schuster, 1944.

U.S. Air Force. Air Training Command. History of the United States Air Force (ATCP 190-1). June 1961.

U.S. Air Force. Pacific Air Forces. Directorate of Civil Engineering. "PACAF Civil Engineering Information Bulletin (PACAFRP 85-1)," (Var issues) 1965-1967.

U.S. Air Force. Preliminary Evaluation of Subgrade Soils: interim airfield, Phan Rang, 27 September 1965. Kirtland AFB, N.Mex.: Soil and Rock Mechanics Section, AF Weapons Laboratory, 1965.

U.S. Army. Air Corps. Office of the Engineer, HQ, Iceland Base Command. "Keflavik Project Report," (2 vols). Nov 1941-Oct 1943.

U.S. Army. White Sands Signal Agency. "Missile Geophysics Program: White Sands Missile Geophysics Research Tower" (Special Report No. 7), July 1957.

U.S. Congress. House. Committee on Armed Services. Special Subcommittee. Construction of Military Hospital Facilities. 88th Congress, 2nd Session. Washington, D.C.: GPO, 1964.

U.S. Congress. House. Committee on Armed Services. Subcommittee for Special Investigations. Airstrip Paving Materials. 85th Congress, 1st Session. Washington, D.C.: GPO, 1957.

U.S. Congress. House. Committee on Armed Services. Subcommittee for Special Investigations. Deterioration of Runway Facilities at Selfridge Air Force Base. 88th Congress, 1st Session. Washington, D.C.: GPO, 1964.

U.S. Congress. House. Committee on Expenditures in the Executive Departments. Special Subcommittee. Military Housing Construction in Alaska. 82nd Congress, 2nd Session. Washington, D.C.: GPO, 1952.

U.S. Congress. Senate. Committee on Armed Services. Preparedness Investigation Subcommittee. Inquiry Into the Collapse of Texas Tower No. 4. 87th Congress, 1st Session. Washington, D.C.: GPO, 1961.

U.S. Congress. Senate. Committee on Government Operations. Permanent Subcommittee on Investigations. Work Stoppage at Missile Bases. 87th Congress, 1st Session. Washington, D.C.: GPO, 1961.

U.S. Department of the Air Force. USAF Historical Studies: No. 83, The United States Army Air Service in World War I. Undated typescript, Albert F. Simpson Historical Research Center, Maxwell AFB, AL.

U.S. Department of the Air Force. USAF Historical Studies: No. 98, The United States Air Arm: April 1861 to April 1917. Maxwell AFB, AL.: USAF Historical Division, Research Studies Inst., Air University, 1958.

U.S. Department of the Air Force. USAF Historical Studies: No. 126, The Development of Continental Air Defense to 1 September 1954. Undated typescript, Albert F. Simpson Historical Research Center, Maxwell AFB, AL.

U.S. Department of the Air Force. USAF Historical Studies: The United States Air Arm Between the Wars. Unpublished draft, Albert F. Simpson Historical Research Center, Maxwell AFB, AL.

U.S. Department of Transportation. Airports and Their Environment: A Guide to Environmental Planning. (DOT P 5600.1) Cambridge, Mass: CLM/Systems, Inc., 1972.

A discussion of the many factors and problems bearing upon modern airport planning and regional planning. Incl annot. bibl.